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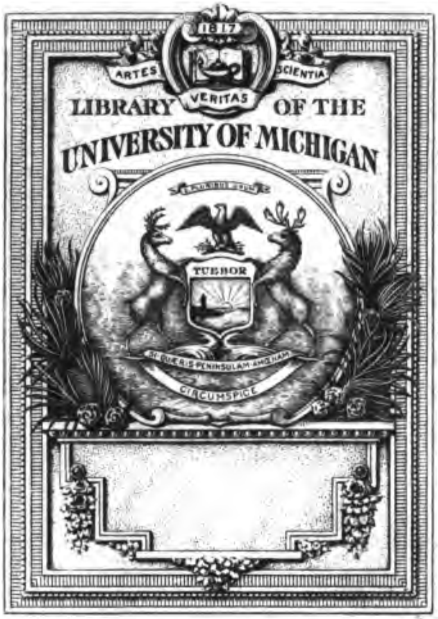
Twenty-ninth Annual Convention

OF THE

American Railway Bridge and Building Association

1919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PROCEEDINGS OF THE

Twenty-Ninth Annual Convention

OF THE

American Railway Bridge and Building Association

Successor to the

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF
BRIDGES AND BUILDINGS

HELD AT

CLEVELAND, OHIO

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Obituary

G. W. Andrews, M. of W. Dept., B. & O., Baltimore, Md.
J. H. Cummin, Insp. of Heating, L. I., Jamaica, N. Y.

Proceedings of the Twenty-ninth Annual Convention
of the
American Railway Bridge and Building Association
Held at the Statler Hotel
Cleveland, Ohio, October 21-23, 1919

The twenty-ninth annual convention of the American Railway Bridge and Building Association was called to order in the convention hall of the Statler Hotel, Cleveland, Ohio, at 10:30 Tuesday morning, Oct. 21, 1919, by Lee Jutton, President, who called on J. H. Cummin to open the convention with prayer.

The President:—We are indeed fortunate to have present with us this morning the leading railroad man of Cleveland, a man who was once a member of the bridge and building department. He knows something of the problems with which we have to contend, and can sympathize with us. I refer to Mr. D. C. Moon, assistant to the federal manager of the New York Central Lines, who will make the opening address.

D. C. Moon:—Mr. President, Ladies and Gentlemen: I fail to see the Mayor of the city here to welcome you, and, therefore, as a fairly old citizen of this city I am going to take the liberty of offering a welcome to our city of Cleveland. I think that those of you who have never been here before will find it one of the most interesting cities that you have ever visited. We are all very proud of it.

When I was invited by your chairman of the entertainment committee he mentioned my saying a few words. I couldn't refuse an old Lake Shore man, so I consented. Afterwards I saw I was booked for an address, something that I really never gave in my life.

I feel much like the little boy who went to school for the first time, at the age of six. The teacher promptly went around to him and asked his name, age, etc. Among other things she said, "Johnnie, do you know your A B C's?" and Johnnie replied, "Hell no, I have only been here five minutes. What do you expect?" (Laughter.)

In the presence of you technical and practical bridge and building experts, I feel the diffidence of a layman, and have found it difficult to think how I can best entertain you about the line of work for which you have a special training and a greater knowledge of the detail than I. However, I will try and give you a few ideas from my own life observations and trust they may be helpful to some of you at least.

My first experience on bridge work goes back to my age of about ten years, when my father took a contract, of some importance in those days, to build a two-bent highway bridge across a 20-ft. creek and in mud strata drove piling with a wooden hammer, weighing perhaps 200 lb., operated by horse power. I was the "handy jack" to haul back the hammer line, which, to me, was a most arduous and tiresome job. Since then, however, with over 40 years of railroad service, and a good part thereof in operating supervision, including maintenance and construction, I have taken great interest in that part of the work which the bridge and building engineers specially represent.

Railroad bridge building in its early progress from pile and frame and mud sill trestles and "bow-backs" to the more scientific "Howe Truss" with the tension rods put in unison by a "piano tuner" has afforded the greatest of opportunity for ingenuity and creative effort as shown by the great variety of spans and structures built, because whether for temporary and quick repair after a washout, fire, wreck, or other casualty, or to prepare for a fill, or to make a permanent structure, it must be made perfectly safe for a heavy moving load, and the width of the stream or water-way; the emergency flood; the ice gorge; flood wood; wash of banks and bed; the sweep and speed of current, and the tendency to undercut; the strata of soil, etc., all must be most seriously and carefully considered for a conclusion as to the location, form and quality of foundations for abutments and piers, regardless of the form of superstructure, and it requires the best of judgment to meet the practical requirements for safety and permanency with a good reasonable allowance for both, while at the same time not going so far as to be wasteful or extravagant in cost with company funds, because bridge building at best is a very costly necessity in railroad construction and maintenance, and the earnings of a bridge costing, say $1,000 per lineal foot, is no greater than for the same length of track costing $5 per foot.

Each waterway, little or big, has its own peculiar characteristics and that applies to all from the six inch drain pipe to the biggest bridges ever built. Practical brainwork is especially needed in this, the preparatory stage of the job, and I do not hesitate to suggest to bridge engineers that they freely consult the old residents, the farmers, the millmen or the woodmen of the neighborhood about the characteristics of the stream; they have seen it at its worst and often can give historical and valuable information that may prove very useful, especially for new construction.

This foundation work is, of course, of the greatest interest, and has to be coupled up with nature's conditions and that of the structure you desire or may be required to build. Formulas and technical training are useful, but after all, of rather minor importance for this part of the work. Therefore, I urge all to be most painstaking and thorough in these elemental features. After these first points are fully determined, then naturally the more technical application of construction, coupled with good judgment, can be featured to the utmost.

How to construct the foundations and component parts to carry the structure that is to be built and that may be selected according to service necessities, is rather easily determined, after the elemental facts have been obtained as described. Will it be a modern type for one, two, three, four, or more tracks; how much head and span clearance is required; is it to be a through or deck girder, or concrete arch, or combination; is a draw or lift to be provided for? Usually these points are easily determined and then the technical part of the effort comes strongly into play, and the designing of the entire job, including the temporary support; the erection (especially if under traffic) of the type decided upon from among the great number of possibilities, requires the highest skill and education of the art along technical lines and from formulas worked out of experience. But, my friends, keep this ever bright before you,—that technical knowledge alone will never constitute success in railroad bridge building; couple it up with brains, apply deep practical thought and practical judgment, and experience, and then it will accomplish everything.

My personal observations and experiences led me long ago to feel that as between the so-called practical " horse sense " and the technical or book knowledge separated, I would select for a majority of the jobs, the man with the former qualifications. You can buy books and technical knowledge, but you cannot buy brains. The purely technical man has usually proven a costly theorist, as many an employer has found out to his sorrow. But the practical man has moved along on safe lines, and been the employer's benefactor. Strive to be a combination man in every sense, and with that you surely will be a success.

Ten years as general manager of the Lake Shore Railroad, and many other years of experience and observation, lead to the conclusion that my remarks about bridge work are so applicable to buildings, and all other structures of railroad maintenance and construction, that special reference to the latter is unnecessary. Whether it be warehouse, stations, shops, coal docks, cinder pits, water tanks, or what not, the location, foundations and type of structure can be usually selected for material advantage of convenience and economy, and the practical good judgment, in this respect, here again, is foremost.

For closing, I will give you a few illustrating points, and I believe you will clearly get my idea:—

Many years ago a young engineer was in charge of some bridge construction on a new line in a hilly country and crossing the smaller or west branch of a stream, he built a 200-ft. span " Howe truss." Then about 20 miles below the confluence of the east and west branches, and crossing the main stream, where more than double the water flowed, he built another similar span 200 ft. long, that afterward proved to be ample; years later both required renewal and were replaced with steel, but years of observation led me to shorten the upper bridge to 100 ft., or half of original length, at considerable saving, and still later the original engineer riding over the road with me, confided as an old friend, that years ago, but after building the original structures, he had discovered that usually not as large bridges are required near the source as at the mouth of a stream, but he had kept his boyhood mistake to himself, letting others find it out for themselves. The promoters paid the bill for extra and useless cost, perhaps never knowing, but it was all there just the same.

Another instance,—An important double-track water way trestle burned out one very stormy night, and bridge builders, trackmen, material and machinery galore, were hurried to the broken point from both directions. In the meantime, the track supervisor, a most practical and competent man, with other "first aid" men, had arrived, rapidly cleared the debris, spiked planks to the piling near the water surface, laid other planks across for platform, and commenced to saw off the burned pile heads about six inches above lake level, to seat temporary bents to carry tracks. Time was everything, accuracy of saw line was nothing as differences could be adjusted during erection by shims. Yet, after the sawing was about half finished on this 400-ft. job, and every man working like Trojans, a young engineer arrived with a level, sent rodmen onto the platforms described, and the saw men just naturally stopped and made way for the engineer work, and it started to cause serious delay. Upon discovery, and the engineer asked why; he explained that he was going to make accurate marking for the saw men. Well, he naturally was quickly cleared away and work progressed. He had not quite sized up the job; he meant well, but his technique rather overbalanced his "horse sense." I am sure this experience opened his mind very wide, and later he was a very much more practical and efficient engineer.

One more illustration:— A few years ago the Lake Shore railroad built a new four-track lift bridge over the Calumet river at Chicago; it raises about 125 ft.; among other things of consequence, the lifting cables are quite an item of weight, for as you know, when the bridge is down they hang mostly inside the towers, whereas, when the bridge is lifting, their several tons of weight are transferred over the top pulleys to the outside, and the equi-balance of the bridge is or would be materially disturbed; and, whereby many high class engineers throughout the world have had more or less difficulty and worry from this source, and heavy lifts have been "passed up" for this reason, where otherwise desirable, and our chiefs and bridge engineers were also worrying me about their troubles during the planning. One day, Mr. Leffler solved the problem—he just hooked up the cable counter weights on the outside, to the pulley derricks, to take up or equalize as the bridge went up or down, and it worked like a charm. Simple? Yes. But from my point of view, more real practical brain concentration was in that little one ideal thought than in all the rest of the job.

Study formulas and technique, for they must be used. But, don't forget to keep your mind working on the practical side of every job. (Applause.)

Chairman:—I will ask Mr. Cummin to make a few remarks in response to Mr. Moon.

J. H. Cummin:—Mr. President and Mr. Moon: I feel this morning somewhat like a cat in a strange garret. Some years ago I thought I was acquainted with every member of this association, but since I left the railroad business about 12 years ago, this association has outgrown my recollections; I have not been able to attend the meetings, and on being called upon by the president to address this assemblage I feel somewhat in the position of the old colored fellow going along the street in a dilapidated condition. The poor old fellow never had a dollar in the world. A gentleman came along and, meeting him, said, " Say, Uncle, please change a ten dollar bill for me, will you? " The old darkey looked up at him and said, " Golly, Massa, I'se sorry I can't do it, but I thanks you for the compliment." (Laughter.)

I would like to say to Mr. Moon that I have enjoyed his remarks a great deal, and I believe that if he will go through the membership of this association he will find that they are pretty close to one hundred per cent practical. They have a great deal of the theory. A large majority of them have attended colleges and secured the theoretical portion of it there, but since they have joined the different companies with which they are now connected they have gained the practical knowledge and they come together at these meetings to give us the benefit of that practical knowledge from year to year. I don't believe there is a member of this association that attends the sessions at these meetings but who goes home a great deal better qualified to fulfill the mission for which the company by which he is employed has engaged him. I thank you. (Applause.)

The President:—Ladies and Gentlemen, as your president it is necessary that I make a few remarks at the present time at the opening of this convention. It is certainly gratifying to see the large number present. I believe we are going to have a good convention. Indeed from the expression on your faces I know that we are going to have a good convention. This is the Twenty-ninth convention of our association. Some here probably will recall the first meeting at St. Louis in 1891, at which there were 60 charter members, I believe, three of whom, I am glad to say, we have here today, J. H. and A. S. Markley and Mr. McNab. In addition I believe that 13 of the 60 charter members are still living. From this start of 60 we now have a membership of 730, and there are something like 80 new members to come in at this convention, so we will be close to 800.

That is very encouraging. It shows that as an association we are healthy and prosperous. The greatest thing that has caused us to be so is the fact that we always work in harmony. There has been practically no strife and dissension in the affairs of our association and we know that when that condition exists any association or any organization cannot help but go forward. I know that this association will continue so, and that our membership will increase greatly year after year.

During the past year death has taken ten members from us. One of these deaths was caused by a motor car accident. A few years ago we lost another member by a similar accident. Now we all know what the " Safety First " movement is. We know that it has reduced the number of deaths and injuries on the railroads to a very great extent.

I think that it would be well at this time to emphasize this safety movement somewhat. I believe that motor car accidents, in fact, all accidents, are more or less avoidable. We have many accidents that can be avoided, and I hope that every member of this organization will make a resolve that there will be no decrease in membership from now on due to motor car accidents or those of any other kind. This subject is especially fitting at this time, because we are now in the midst of the National Railroad Accident Prevention drive. I know that every one of our members will do all he can to come out one hundred per cent perfect so that it can be said that the Bridge and Building men did their part to eliminate accidents and to advance this accident prevention drive. The safety movement is a great thing, and it is worthy of every attention and effort we can give it.

This is the first convention of our association since the close of the war. We had something like thirty members serving in the Army of this country. We are proud of their record. They did their work and did it well. The war record of our association is something to be proud of. Every man did his part, knowing that it was necessary to keep the railroads of this country in a high state of efficiency for the transportation of men and munitions. Knowing that, I believe that every one of us sacrificed a good deal of personal comfort in order to see that the work was properly done at all times.

Furthermore, we are a part of the greatest industry in this country. The railroads are vitally necessary to the welfare of the country, and being so, they must advance and improve. I know that the members of this association have kept abreast of the times. Nothing has been put up to them in the way of improved conditions or new methods of doing work that they have not mastered. They have met new conditions and have produced results—and good results. The last few years the conditions under which the railroads have had to operate have been severe, and we have been called upon to do things that we never thought we would have to do. You well know the trouble with labor, what we have had to contend with. The hours have been reduced and the amount of labor that we got for one hour has been considerably reduced. The price of materials has advanced to unthought-of figures. Under these conditions we have been asked to produce results, and I must say that the results have been forthcoming. We have had to give more time and attention to the details of the work, and under those conditions we have won out.

Last summer the secretary of our association and I visited Cleveland to confer with the committee on arrangements, and what we saw on that day convinced us that our association had made no mistake in choosing this city for its convention. You will find Cleveland filled with large industries, everything up-to-date, and will be well repaid for your trip here. I also wish to thank the committee on arrangements at this time for the work they have done. I know that they have worked long and hard in perfecting the arrangements for this convention, and I know that we all appreciate it. It is certainly fine to see the large number of ladies present. I hope our new members will appreciate this and see that their wives and daughters get the convention habit. This means, of course, that we have a large number of new ladies at every convention. They also need some attention. They should be made to feel welcome, and to be shown that we have a very happy convention family.

The committee reports for this convention are especially good. A lot of work has been put on them, and I feel that we are going to get a great deal of good from them. The thanks of the association are due the men who have worked in making up these reports, but, as has been said before, their real reward is in the knowledge gained in working up the reports. It will be well for the other members to profit by their work, by studying these reports and entering into the discussions very fully.

In closing I want to say that I hope that the men will attend the business sessions, every one of them. Let us pay strict attention to business, for in so doing we will feel better when it is over, and enjoy more fully the pleasures that have been prepared for by the committee on arrangements. I thank you. (Applause.)

I will appoint F. E. Weise assistant secretary.

Before the ladies retire we will ask R. H. Reid, chairman of the committee on arrangements, to give us an outline of what has been arranged in the way of entertainment.

(Mr. Reid announces the various features of entertainment.)

The ladies may now retire.

If there is no objection we will dispense with the reading of the minutes of the last meeting, as they have been published and all have had an opportunity to read them. The reading of the minutes of the executive committee will also be dispensed with for the same reason.

Instead of a roll call we have adopted the card registration system. Our members are requested to register at the secretary's office just outside the convention hall.

(The registration showed the following members in attendance:)

P. Aagaard
C. J. Allen
L. J. Anderson
G. W. Andrews
F. C. Baluss
E. K. Barrett
J. M. Bibb
S. C. Bowers
G. Boyer
J. B. Browne
J. E. Buckley
F. L. Burrell
W. M. Camp
W. M. Cardwell
F. M. Case
A. J. Catchot
W. A. Clark
F. J. Conn
A. C. Copland
S. T. Corey
G. M. Cota
L. A. Cowsert
J. H. Cummin
W. L. Darden
E. A. Demars
C. E. Donaldson
J. Dupree
J. A. Dyer
F. A. Eskridge
C. Esping
C. Ettinger
R. F. Farlow
G. Fenwick
C. F. Flint
F. Gable
B. F. Gehr
Ira Gentis
O. C. Gongoll
C. Gradt
F. N. Graham
J. Gratto
F. M. Griffith
E. Guild
L. D. Hadwen
W. S. Haley
Thos. Hall
A. W. Harlow
W. C. Harman
A. T. Hawk
J. Henderson
R. C. Henderson
P. Hofecker
G. M. Hoffman
W. T. Hopke

H. A. Horning
W. B. Hotson
E. T. Howson
J. Hunciker
J. S. Huntoon
J. Innes
A. J. James
R. E. James
J. O. Jewell
M. Johnson
Lee Jutton
A. E. Kemp
R. Kendall
A. H. King
F. A. Knapp
C. R. Knowles
H. M. Large
W. V. Lattin
P. P. Lawrence
J. S. Lemond
A. Leslie
C. A. Lichty
E. L. Loftin
W. Mahan
J. M. Mann
G. A. Manthey
A. S. Markley
J. H. Markley
W. H. Matthews
E. M. McCabe
A. G. McKay
W. S. McKeel
A. McNab
W. F. Meyers
A. F. Miller
C. J. Moore
H. Morgan
C. T. Musgrave
D. G. Musser
G. K. Nuss
T. E. O'Brien
P. J. O'Neill
F. C. Osborn
J. A. Owen
W. V. Parker
J. Parks
W. A. Pettis
R. Pierce
J. F. Pinson
H. H. Pollock
G. W. Rear
D. L. Rehmert
R. H. Reid
H. Rettinghouse
A. W. Reynolds
G. T. Richards
A. Ridgway
M. Riney
A. C. Roberts
J. S. Robinson
G. A. Rodman
W. A. Rogers
W. L. Rohbock
A. Ruge
F. E. Schall
C. Scott
C. J. Scribner
A. C. Shields
C. A. Sibley
E. L. Sinclair
C. U. Smith
E. W. Smith
R. W. Smith
F. H. Soothill
L. Spalding
J. Spencer
G. H. Stewart
E. G. Storck
W. F. Strouse
H. C. Swartz
W. G. Swartz
Wm. Sweeney
A. M. Swenson
J. L. Talbott
S. C. Tanner
D. B. Taylor
F. A. Taylor
J. J. Taylor
E. M. Tucker
T. B. Turnbull
W. J. Tyers
O. E. Ullery
C. G. Vollmer
C. F. Warcup
P. N. Watson
F. E. Weise
G. W. Welker
E. R. Wenner
J. B. White
J. L. Winter
C. F. Womeldorf
J. W. Wood
C. W. Wright
R. C. Young
E. C. Zinsmeister

The following list of applicants, subsequently elected to membership, were also present:

L. B. Alexander
E. B. Brink
F. Burns
M. M. Carmody
L. Clapper
J. B. Clarke
M. M. Corrigan
J. K. Davidson
E. Drury
J. L. Enright
L. Firehammer
W. R. Gantz
J. M. Gibson
H. J. Groeninger
R. H. Helick
R. F. Henry
C. W. Heuss
B. J. Howay
E. H. Johnson
T. P. Johnston
W. E. Keir
E. K. Lawrence
F. C. Loweth
C. W. McFarland
F. H. Mitchell
W. J. O'Brien
T. O'Hara
J. L. Pickles
C. P. Rawson
H. W. Roberts
H. C. Shealy
R. E. Sheehan
J. P. Smallenberger
B. F. Stidfole
O. C. Till
J. H. Vosburgh
H. B. Watters

Total number of members present, 196.

The President:—The next order of business is the election of new members. The membership committee, under the leadership of Mr. Horning, has been doing some good work, and it has a long list of applicants for membership. The secretary will

read the report of the committee together with the list of applications.

REPORT OF MEMBERSHIP COMMITTEE

The membership committee experienced an active season and is able to report a large number of applications from various parts of the country. The committee was materially assisted by many members and especially by the secretary.

Considerable difficulty was met in reaching many who were eligible but whose names did not show in the official lists. We call particular attention to this feature, for it is hoped that membership committees in the future may receive aid from all of the members in locating and going after such men, as it is important that we should extend an invitation to all who are eligible to become members.

The committee recommends for your consideration the following list of applicants for membership.

(Signed) The Committee.
By H. A. Horning, Chairman.

List of Applicants for Membership

Alexander, L. B., Asst. Br. Engr., M. C., Detroit, Mich.
Beck, L., Supt. B. & B., Virginian, Victoria, Va.
Bennett, W. J., Asst. Engr., G. N., Seattle, Wash.
Bracken, T. F., G. F. B. & B., C. St. P. M. & O., Emerson, Neb.
Brink, E. B., Supt. B. & B., L. E. & W., Tipton, Ind.
Bugg, C., Supv. W. S., G. T., London, Ont.
Buchholz, H. C., Ch. Carp., C. M. & St. P., St. Maries, Idaho.
Burns, Fred, G. F. Carp., C. N. O. & T. P., Somerset, Ky.
Carmody, M. M., Supv. B. & B., Sou., Big Stone Gap, Va.
Cavanaugh, Wm., Asst. Supv. B. & B., N. Y. C., Oswego, N. Y.
Chapin, F. H., Asst. Br. Engr., Alaskan Eng. Com., Anchorage, Alaska.
Clapper, L., Engr. B. & B., D. & I. R., Two Harbors, Minn.
Clarke, J. B., B. & O., Chillicothe, O.
Corrigan, M. M., Gen. Insp. Tunnels, B. & O., Cumberland, Md.
Crawford, I. C., Supv. B. & B., D. & R. G., Salt Lake City.
Crosby, P., Supv. B. & B., N. Y. N. H. & H., Danbury, Conn.
Davidson, J. K., Mast. Carp., Pa. Lines W., Jamestown, Pa.
Drury, Edwd., G. F. B. & B., A. T. & S. F., Newton, Kans.
Enright, J. L., Gen. Supv., B. & B., St. L. S. W., Tyler, Tex.
Estes, F. K., Asst. Supv. B. & B., U. P., Denver, Colo.
Everett, D. D., For. Plumb., Erie, Jersey City, N. J.
Firehammer, L. M., Supv. B. & B., Ill. Trac., Gillespie, Ill.
Gallagher, J. P., Insp. Fire. Protec., N. Y. C., New York, N. Y.
Gantz, W. R., Mast. Carp., P. R. R., Philadelphia, Pa.
Gault, A. K., Div. Engr., C. & N. W., Omaha, Neb.
Getman, Frank, Mast. Carp., Erie, Youngstown, Ohio.
Gibson, J. M., Supv. B. & B., G. T. R. in New Eng., Portland, Me.
Groeninger, H. J., Mast. Carp., P. R. R., Oil City, Pa.
Hamer, John, Supv. Bldg., N. Y. C., Albany, N. Y.
Hanson, J. A., Supv. B. & B., C. C. C. & St. L., Mt. Carmel, Ill.
Hawken, F. G., Insp. B. & B., D. S. S. & A., Marquette, Mich.
Helick, R. H., Mast. Carp., P. R. R., Pittsburgh, Pa.
Henry, R. F., Supv. B. & B., C. C. C. & St. L., Galion, Ohio.
Heuss, C. W., Supv. B. & B., C. C. C. & St. L., Indianapolis, Ind.
Howay, B. J., For. B. & B., P. M., Saginaw, Mich.
Hull, H. L., C. C., Eng. Dept., C. T. H. & S. E., Chicago, Ill.
Jackson, C. T., Dist. Engr., C. M. & St. P., Chicago, Ill.
Jamison, G. H., Ch. Carp., C. M. & St. P., Harlowtown, Mont.
Johnson, B. L., Genl. Mast. Carp., G. N., Spokane, Wash.
Johnson, E. H., For. Plumb., Erie, Elmira, N. Y.

Johnston, T. P., R. E., Sou. Pine Assn., New Orleans, La.
Keir, W. E., G. F. W. S., A. T. & S. F., San Bernardino, Calif.
Kemmerer, W. G., Asst. Mast. Carp., P. R. R., Erie, Pa.
Lawrence, E. K., Gen. Scale Insp., B. & O., Baltimore, Md.
Livingston, J. B., Supv. B. & B., St. L. S. W., Illmo, Mo.
Loweth, F. C., Asst. Trk. Elev. Engr., C. M. & St. P., Chicago, Ill.
Mansfield, A. G., Ofs. Engr., C. M. & St. P., Seattle, Wash.
McFarland, C. W., For. Carp., P. & R., Reading, Pa.
McHugh, W. H., Mast. Carp., P. R. R., Olean, N. Y.
Meier, G. A., For. B. & B., O. S. L., Brigham, Utah.
Miller, R. E., Brdg. Engr., St. L. S. F., St. Louis, Mo.
Mills, E. A., Gen. Mast. Carp., G. N., Crookston, Minn.
Mitchell, F. H., Mast. Carp., P. R. R., Ft. Wayne, Ind.
Musson, C. A. W., Asst. Engr., C. M. & St. P., Seattle, Wash.
Oaksmith, A., Supt. B. & B., Md. Elec. Rys., Annapolis, Md.
O.Brien, W. J., Dist. Carp., C. M. & St. P., Milwaukee, Wis.
O'Hara, T., B. & B. Mast., C. P. R., London, Ont.
Oppelt, H. H., Supv. B. & B., N. Y. C. & St. L., Conneaut, Ohio.
Perry, C. H., Div. Engr., C. & N. W., Antigo, Wis.
Pettis, C., Gen. Scale Insp., N. Y. C., Rochester, N. Y.
Pickles, J. L., Div. Engr., D. W. & P., West Duluth, Minn.
Rawson, C. P., Archt., C. M. & St. P., Chicago, Ill.
Rees, Edw., Br. Insp., L. I., Jamaica, N. Y.
Rivers, H. B., Ch. Carp., C. M. & St. P., Deer Lodge, Mont.
Roberts, H. W., Mast. Carp., P. R. R., Erie, Pa.
Scott, C. E., Eng. Brgs., M. C., Detroit, Mich.
Shealy, H. C., Mast. Carp., S. A. L., Hamlet, N. C.
Sheehan, R. E., Supv. Brdgs., C. B. & Q., Chicago, Ill.
Silcox, H., Mast. Carp., P. R. R., Jersey City, N. J.
Smallenberger, J. P., Mast. Carp., Erie, Meadville, Pa.
Stidfole, B. F., Mast. Carp., P. R. R., Bordentown, N. J.
Taylor, Geo., Asst., Engr., Sou. Pac., Dunsmuir, Calif.
Till, O. C., Mast. Carp., Belt Ry. of Chicago, Chicago, Ill.
Tuthill, G. C., Brdg. Engr., M. C., Detroit, Mich.
Vosburgh, J. H., Supv., B. & B., N. Y. C., Watertown, N. Y.
Watters, H. B., Ch. Engr., D. T. & I., Springfield, Ohio.
Weed, J. A., Supv. B. & B., O. S. L., Pocatello, Idaho.
Welch, F. J., Ch. Carp., C. M. & St. P., Tacoma, Wash.
Wier, J. M., Ch. Engr., K. C. S., Kansas City, Mo.
Wuerth, H., Asst. Engr., C. M. & St. P., Chicago.
Total number of applications, 80.

H. A. Horning:—I move that the secretary be authorized to cast a single ballot for the membership of the entire list. (Motion duly seconded and carried.)

G. W. Rear:—I move that the names of all applicants which are presented during the convention and receive the endorsement of the membership committee be placed on the roll as members.

The Chairman:—That I believe is customary, and unless there is objection we will see that that is done. We will now have the report of the secretary-treasurer.

REPORT OF THE SECRETARY-TREASURER

Since we met last year we have passed from wartime into the reconstruction period. On account of war conditions and the influenza epidemic, both of which were at their height when we met last, the attendance at our last meeting was less than that at any convention since we met at Montreal in 1913. We are extremely fortunate in being able to state that we lost none of our members in army service and only one as a result of the influenza. This is truly a remarkable record when we recollect the conditions that confronted us a year ago. The outlook last year was the darkest in our history.

We have been called upon to chronicle the loss of 10 of our members by death during the past year. Wm. G. Hicks died Dec. 11, 1918; J. W. Little died Feb. 5, 1919; Chas. Dale died Feb. 9, 1919; J. J. Evans, date lacking; W. M. Noon died April 27, 1919; Wm. Spencer died June 1, 1919; John B. Sheldon died July 2, 1919; A. Mountfort died Sept. 26, 1919; W. E. Alexander died Oct. 5, 1919; Z. T. Brantner died Oct. 22, 1919. Memoirs of these members will appear in our proceedings.

Our membership has increased steadily during the past three or four years. Annual dues have been paid up more promptly and in greater proportion during the past year than for many years. Our finances are holding their own and it may truly be said that the Association is in a healthy and prosperous condition.

The financial report follows:

Chicago, Oct. 10, 1919.

Financial

Balance on hand at last report,		$1,043.79

Receipts

Dues and fees,	$1,300.00	
Advertising,	1,197.10	
Sale of badges,	15.50	
Sale of books,	24.85	
Interest,	39.25	
Total,		$2,576.70
Total on hand and received,		$3,620.49

Disbursements

Postage,	$ 108.05	
Printing and engraving,	1,065.31	
Stationery and office supplies,	14.85	
Editing,	70.00	
Stenographer,	80.20	
Expenses various committees,	30.00	
Badges,	37.50	
Salaries and office rent,	800.00	
Convention expenses,	55.30	
Telephone and telegraph,	11.85	
Miscellaneous,	21.65	
Total,		$2,294.71
Balance on hand Oct. 10, 1919,		$1,325.78

Of the above amount $500 has been invested in Liberty bonds bearing 4¼ per cent interest, and $300 in a first mortgage note at 6 per cent. The balance of $525.78 is on hand in the bank.

Respectfully submitted,

C. A. Lichty,
Sec.-Treas.

The President:—I will appoint a committee consisting of J. S. Robinson, F. E. Weise and R. C. Sattley to audit the books and accounts of the secretary-treasurer.

I will also appoint G. W. Andrews, S. C. Tanner and C. W. Wright a committee on resolutions. They will present their report at the close of the convention.

We will next hear the report of the committee on relief.

REPORT OF THE COMMITTEE ON RELIEF

Chicago, Oct. 18, 1919.

The committee on relief did not receive a call from any of our members asking for assistance in any manner, which indicates that none have been in want for employment.

The committee offers its assistance to those in need of positions at any time.

C. R. Knowles,
A. H. King,
G. W. Rear,
Committee.

The President:—We will now receive the report of the obituary committee.

REPORT OF THE OBITUARY COMMITTEE

Cleveland, Oct. 21, 1919.

To the Members of the Association:

Whereas, It hath pleased the Almighty Father of the Universe to call from our midst the following members: W. M. Noon, Wm. G. Hicks, J. W. Little, Chas. Dale, J. J. Evans, J. B. Sheldon, Wm. Spencer, A. Mountfort, W. E. Alexander and Z. T. Brantner,

Therefore, be it resolved, That the members present at this convention express their sorrow at the loss of these brothers by a rising vote, and,

Be it further resolved, That a copy of these resolutions be sent to the families of each of our departed members, and a page of our proceedings be set aside to the memory of each.

Respectfully submitted,

G. W. Andrews,
J. P. Wood
Committee.

The report was adopted and the members in convention arose in response to the resolution.

REPORT OF THE EXECUTIVE COMMITTEE

One meeting of the executive committee was held during the year.

Congress Hotel, Chicago, March 19, 1919.

Meeting called to order by President L. Jutton. Executive members present, L. Jutton, C. R. Knowles, J. H. Johnston, F. E. Weise, E. T. Howson, C. W. Wright and C. A. Lichty. Several past presidents and other members were also present.

R. H. Reid reported on the hotel situation at Cleveland, favoring the selection of the Statler hotel for convention headquarters. He also gave an outline of entertainment features decided on by the committee of arrangements. It was voted to leave the matter of arrangements and selection of hotel for headquarters to the committee together with the president and secretary.

No further business appearing the meeting was adjourned.

Statler Hotel, Oct. 20, 1919.

A meeting of the executive committee was held at the Statler Hotel on the eve of the convention which was called to order by first vice president, F. E. Weise, in the absence of the president.

Executive members present were F. E. Weise, E. T. Howson, C. W. Wright, C. R. Knowles, W. F. Strouse and C. A. Lichty. Past presidents present were G. W. Andrews, H. Rettinghouse, R. H. Reid, and J. H. Cummin.

R. H. Reid reported for the committee on arrangements stating what had been planned for entertainment, etc.

C. W. Wright made a motion to have a committee appointed to investigate our finances and report on the advisability of increasing the annual dues, and offering any necessary amendments to the Constitution, which motion was carried. The meeting then adjourned.

C. A. Lichty, Secretary.

Several letters and telegrams were read which had been received from members who found it impossible to be at the convention.

The President:—This completes the preliminary business. We will take up one of the subjects for report and discussion this forenoon. Mr. Ridgway desires to get away this evening and we will therefore take up the report of the committee on Methods of Bridge Inspection Under Present Conditions, of which he is chairman. (See report and discussion.)

Adjourned at 12:30 to re-convene at 2 o'clock.

AFTERNOON SESSION

Tuesday, Oct. 21, 1919.

The President:—We will continue the discussion on the report of the committee on Bridge Inspection.

When the discussion was concluded a letter was read from Col. Geo. H. Webb, chief engineer of the Michigan Central wherein he stated that it would be impossible for him to be present to take part in the program for Tuesday evening when he was to make an address on the work that he was connected with in France.

The second report taken up was that of Inspection and Repairs of Roofs. In the absence of the chairman the secretary read the report. (See report and discussion.)

The next subject taken up was that of Methods and Equipment used in Renewing Timber Bridges which was read by the chairman, Maro Johnson. (See report and discussion.)

The meeting adjourned at 5 p. m. to reconvene at 9: 30 a. m. Wednesday.

MORNING SESSION

Wednesday, Oct. 22, 1919.

The meeting was called to order by President Lee Jutton at 9: 30 a. m.

The President:—We will hear the report of the nominating committee. The secretary will please read the report.

REPORT OF THE NOMINATING COMMITTEE

Cleveland, Nov. 22, 1919.

The committee on nominations recommends the advancement of the present officers and executive members one step as has been the custom (except the secretary-treasurer who is renominated), and that the name of G. A. Manthey be added to the executive committee to fill the vacancy caused by the promotion of the other members.

Respectfully submitted,

L. D. Hadwen,
S. C. Tanner,
A. Montzheimer,
Committee.

REPORT OF THE AUDITING COMMITTEE

Cleveland, Oct. 22, 1919.

The auditing committee has examined the books and accounts of the secretary-treasurer and has found them to be correct as given in the report.

J. S. Robinson,
F. E. Weise,
R. C. Sattley,
Committee.

The President:—The next in order of business is the presentation of a paper entitled Internal Combustion versus Steam Engines for Pumping Water, by C. A. Lichty.

(See paper and discussion.)

Following the discussion the report on Painting of Metal Railroad Structures was presented by C. T. Musgrave, the chairman. (See report and discussion.)

F. E. Weise:—A number of our members who were here Monday visited the plant of the Sherwin-Williams Co., and while there we invited Mr. George G. Mowat of that company to be present and take part in the discussion of this subject. Mr. Mowat has found it necessary to be out of the city today so he sent Mr. Swaney to read his paper.

(See paper and remarks by Mr. Swaney.)

The meeting adjourned at noon until 8: 30 a. m. Thursday, to permit an inspection to be made of the Orange Ave. freight terminal and the Pennsylvania ore docks in the afternoon.

MORNING SESSION

Thursday, Oct. 23, 1919.

Meeting called to order at 8: 30 a. m. by President Jutton.

C. R. Knowles read his paper on Railway Fire Protection Equipment. (See paper.)

Mr. Knowles also presented the committee report on the Economical Use and Storage of Fuel at Railway Pumping Stations. (See report.)

Discussion was first taken up on the latter subject, and later on Fire Protection Equipment. (See discussion.)

The President:—We will now proceed with the selection of the next place for holding the convention. Nominations are in order.

F. C. Baluss:—Our time is short, and I am not going to take a lot of time talking about this matter. I wish to place in nomination the city of Atlanta, Ga. It is well located geographically, and is a delightful place to hold a convention.

A. S. Markley:—I second the nomination. We held our 1901 convention there and we had a very fine time. The people turned out and gave us a barbecue and other amusements that were unique and interesting.

H. Rettinghouse:—Three years ago this convention voted to hold its next annual meeting in St. Paul. Owing to conditions over which we had no control, the place was changed to Chicago. At the time Mr. McGonagle and myself supported any move that was made to hold the convention in Chicago, doing away with entertainment features, etc. I know that many of the members would be very glad to please Mr. McGonagle. Owing to the great interest that he has always taken in the association and the great benefit that we have derived from this interest, I think that this association is morally obligated to vote for St. Paul for the next convention, and I place that city in nomination. We are at the point of returning to corporation control, and we can have our old fashioned conventions again. If you come to St. Paul I can assure you you will have just as nice a convention, just as good entertainment, as you had some years ago when you came to Minneapolis. In talking with Mr. McGonagle about it

I found that undoubtedly a trip could be arranged over the Iron Range. You have seen here the one end of the ore handling; you can see the other end there, both as to the production of ore and the loading, etc. We have also thought to give you a boat trip among the islands, at Ashland, Wis., one of the most beautiful spots on earth. If we can take the time, I can assure you that you will have a profitable side trip.

G. W. Rear:—I believe that Mr. Rettinghouse is right. This convention does owe an obligation to St. Paul. We voted for St. Paul almost unanimously, time and again, and then it did not get the convention. I believe we are duty bound to go to St. Paul and I second the nomination.

J. Dupree:—Mr. Chairman, I nominate Seattle, Washington.

C. R. Knowles: I simply want to add my bit to Mr. Rettinghouse's remarks about St. Paul. I think we are morally obligated to go there, and I want to express myself in favor of St. Paul.

R. H. Reid:—In seconding the nomination of St. Paul I concur in what Mr. Rettinghouse has said. We are under moral obligation to go to St. Paul, since we voted two years ago to go to St. Paul and certain preparations were made. Later the meeting was changed to Chicago, and St. Paul very gracefully acquiesced in the change. They conceded Chicago for a second time last year. We have been in the South two or three times since we were in the Northwest. We have been in the West and the East since we were in the Northwest. We have been in each principal section of the country since we were in the Northwest. I think it is only fair to Mr. McGonagle and the members from the Northwest that we hold a convention next year in their section.

The President:—We will vote on Atlanta and St. Paul, the other nominations not having been seconded.

A standing vote resulted in St. Paul receiving 56 and Atlanta 53 votes, to which A. S. Markley took exception and called for a ballot.

The ballot resulted as follows: Atlanta 82, St. Paul 66, whereupon the president declared that Atlanta would be the meeting place for the 1920 convention.

Chairman:—We will hear the report of the Committee on Subjects.

F. E. Weise:—The announcement was made from the platform inviting you to offer suggestions for subjects for the coming year. Quite a number have responded. If you have any special subjects that you wish to have considered, you can present them in writing later on, and if the executive committee finds it desirable, it will work them in. Following is the list of subjects as recommended by the committee.

REPORT OF COMMITTEE ON SUBJECTS

Cleveland, Oct. 23, 1919.

The committee on subjects begs to submit the following list to be reported on at the next convention:

1. Filling Bridges (with special reference to the maintenance of structure during period of filling).
2. Standard Forms for Bridge Inspection.
3. The Abuse of Treated Timbers.
4. Repair and Maintenance of Tank Hoops.
5. Maintenance and Repair of Freight House Floors.
6. The Use of Electricity for Pumping Water.
7. Application of Paint by Spraying.
8. Maintenance of Timber Docks.
9. Reclamation of Bridge, Building and Water Service Materials.

The committee further recommends that the practice of presenting papers on special subjects be continued as has been the practice in recent years.

O. F. Dalstrom,
F. E. Weise,
E. T. Howson,
Committee.

It was moved the report of the committee on subjects be accepted. The motion carried.

R. H. Reid:—I would like to get in a word in connection with the report on subjects. I want to urge on all the members that, when the questionnaires come from the chairmen of these various committees, everyone respond, and give all the information you can. It is only by getting full information that we can get the best results. There are things that may seem common to us, individually, but they may be of great interest to some others who have not had particular experience along those lines. By getting complete information and advance discussion, sometimes in writing, we can make the association a complete success. That is what makes a live association and a live convention—good committee reports, good discussion, and where it is advisable, sound recommendation.

G. W. Rear:—I would like to add a word to that. In sending out the questionnaire it is very often true that it doesn't go to the right man. It goes to some man who is not particularly interested in the subject where it either becomes buried or is answered in a perfunctory manner. I would suggest that, in the case of a railroad on which the chairman of the committee didn't know the right man to address, he send the questionnaire to some member of this association on that railroad. It would then, in all probability, get into the right hands. I have found numerous cases where the questionnaire didn't get into the right hands, and I have found many times where they have been answered that they have been answered by somebody just to get rid of them.

The President:—We will now have the report of the Committee on Resolutions.

REPORT OF COMMITTEE ON RESOLUTIONS

Cleveland, Oct. 23, 1919.

Resolved:—That the thanks of the Association be extended to the following individuals and corporations:

To Mr. D. C. Moon, for his address of welcome and paper on bridge and building work, read in the convention:

To the United States Steel Corporation for furnishing moving picture films showing the methods of handling iron ore and coal at the docks, and the process of manufacturing steel:

To the New York Central officials for the instructive trip of inspection through the Orange Avenue freight terminal; and for furnishing a special train to convey our members from the Union Station to the Pennsylvania ore docks and return:

To the Pennsylvania Lines West, for their courtesy in assisting our party at its ore and coal docks and operating and explaining the machinery; and also for furnishing transportation and special cars for our party from Cleveland to Akron and return:

To the H. Black Company for its courtesy to the ladies on a trip through their plant:

To the Goodyear Tire and Rubber Co., for a trip of inspection through its plant at Akron:

To the Convention Board of the Cleveland Chamber of Commerce for its efforts and material assistance in making our convention a success:

To the management of the Statler Hotel for courtesies extended:

To the Pullman Company and the New York Central for special cars and rates to and from the convention:

To the officers of the United States Railroad Administration for their encouragement of our Association and its meeting this year, thereby contributing materially to our attendance and the success of the convention:

To the Bridge and Building Supply Men's Association for the exhibits and assistance in making the convention a success:

To the various members of the press in reporting and publishing the various activities of the convention:

To the officers, chairmen and members of the committees, for their time and efforts in carrying on the work of the Association:

Be it further resolved that these resolutions be spread on the minutes and the secretary be instructed to forward copies to all interested parties.

Respectfully submitted,

G. W. Andrews,
S. C. Tanner,
C. W. Wright,
Committee.

Chairman:—That brings us down to the election of officers. The report of the nominating committee, as you heard yesterday is: President, F. E. Weise; 1st Vice Pres., W. F. Strouse; 2nd Vice Pres., C. R. Knowles; 3rd Vice Pres., Arthur Ridgway; 4th Vice Pres., J. S. Robinson; Secy.-Treas., C. A. Lichty.

Members of Executive Committee: J. P. Wood, A. B. McVay, J. H. Johnston, E. T. Howson, C. W. Wright and G. A. Manthey.

G. W. Andrews: I move that the secretary cast a single ballot for the nominees.

(The motion of Mr. Andrews was carried unanimously by a rising vote.)

The Chairman:—Gentlemen, it gives me a great deal of pleasure to announce that our president for next year is Mr. F. E. Weise. Mr. Weise has been a good worker in this association, and the association is to be congratulated on having him for its president. Mr. Weise, I also want to congratulate you for being elected to the presidency of the association. There is nothing that I can say that will add to the able way in which I know that you will conduct the affairs of this association. I am very pleased indeed to present you with the gavel of authority. (Applause.)

Mr. Weise assumes the chair.

The Chairman:—Mr. Jutton and Gentlemen: I can hardly tell you how deeply I appreciate the honor which you have conferred on me by giving me the privilege of serving you this coming year. The association is being turned over to me in better shape than it has ever been before, and I can only repeat what has already been said, that the spirit of the members of the association has never been so evident as it has been at this meeting. Mr. Rear brought that out very forcibly in his talk last night. When this association was first founded nearly 30 years ago, the few people who gathered there did not realize how surely they were building. They met because they felt a need for getting together, exchanging their views and receiving the benefit of each other's experience. They brought their wives with them and they instituted something which has given this association a spirit of friendship and of mutual coöperation which very few associations have to such an extent. I hope that it will be carried on in the future. It is very evident at this meeting, and it has been growing from year to year.

I took occasion during the past year to look through some of the past proceedings of the association. It will do you all good to do that occasionally. You will find that each year the committees presented the very best that they had to give. Our proceedings constitute a record of the best practice for bridge and building men, and each year they have grown better. It is hoped that during the coming year we will be able to keep up the record that has been set. In looking over these proceedings I felt a deep sense of obligation. We are under obligation to those who have worked in the past, because they laid the foundation on which we have been building and thus assured the success of the association.

Personally I felt a deep sense of obligation, because this association has helped me more than I can tell you and in many ways. It has enlarged my acquaintance and enabled me to add to my list of friends many of the ablest railroad men in the country; a friendship that I value very highly. It has also been the means of adding very materially to my knowledge of many subjects that I would otherwise have passed over superficially through committee work and personal interviews with members from all parts of the country. I remember very distinctly the first time the secretary approached me and asked me to serve on a committee. I told him that I did not know anything about committee work and doubted if I could act on a committee. He said he knew better, but he did not tell me that he was going to make me chairman of the committee. I looked over the subject and concluded that it was an easy one. I thought I would not have to work very hard because there did not seem much to say. I thought that our road had the best practice on that particular subject, and all I would have to do would be to tell what we had. But I soon learned that other roads had different plans and methods and that the other members of the committee had ideas of their own. We got together, ironed out our differences, presented the report and, what is more, we formed a lasting friendship. I think that is the experience of most committee members.

I appreciate the privilege of serving you, and I know from the expressions that have been made that you will all do your part in keeping up the standard that has been set by those who have led the way. (Applause.)

C. W. Wright:—As we are on new business now I should like to suggest a life membership for Mr. Charles Wehlen, who has been the bridge inspector of the Long Island Railroad for a long time, and who was retired on July 1 of this year.

G. W. Rear:—It has not been the practice of this association to give honorary membership to all men that are retired from active railroad service. I suggest that we confer life membership on all such.

The Secretary:—We have some charter members here who have paid dues in this association ever since it was organized. They have not asked to be placed on the honorary list or the list of life members, but they are as fully entitled to it as anyone else. The list of those who are actually retired from service is quite a long one, and although our constitution doesn't confine life membership to any certain number, I think it would be a good idea for the executive committee to take this list and determine how many of these men should be placed on our list for life membership. Some of these older members are worthy of it, perhaps all of them are, but I think this is a matter that we should consider very thoroughly before we act.

G. W. Rear:—I would just like to say that I don't consider that the conferring of life membership on anyone is going to be such an enormous obligation. It only reduces our revenues $2 per year for each member. If a man had only been in this association the length of time required by the Constitution, and has reached the age at which he receives a pension or has become retired, the conferring of life membership on him will not deplete the funds of the association to any great extent, while the man who has been a member of this association since its inception, and is still hale and hearty, and in active service, is under no great obligation in paying the regular dues. I urge that we ignore the dues and confer life membership on every man who is retired from his work on account of age.

The Secretary:—Section 3 of Article III in the Constitution reads as follows:

> "To be eligible for life membership a person must have been a member of the Association for at least five years and in general must have retired from active railroad service. The association, however, may waive the latter condition by a majority vote of the members at a regular session for good and sufficient reasons. A life member shall have all of the privileges of active membership and shall not be required to pay annual dues."

We now have about 8 or 10 old members in the association who would like to be placed on the life membership list, and the action that you take at this time will settle that matter. Unfortunately, I do not have the names of all of them with me.

J. H. Cummin:—I find myself in a peculiar position. Some years ago I resigned from the railroad with which I was connected, and at the next meeting of this association the members did me the honor to elect me a life member. I have gone back to the same road, and am now employed by that road, and I don't think it is any more than square that I should come in with my $2 per year. I don't consider that I am entitled to life membership in the association, inasmuch as I have gone back into active service.

P. J. O'Neill:—It always has been the general practice to put on the life membership list those who have been retired from active service. With the membership that we have today the question of the $2 does not enter into consideration nearly as much as it did 15 years ago. We don't miss the $2 now nearly as much as we did then, because our resources are so much greater. I would suggest that we give all retired members a life membership, or else that each individual be acted upon separately; not by the executive committee, but by the members.

G. W. Rear:—The only difference between the life member and the man who isn't the life member is that if a life member doesn't pay his dues, he is not dropped from membership. A man, after retiring, has probably little in the way of resources. He doesn't accumulate so much money, and when he becomes retired, about the first thing he will do is try to cut down the little expenses that he didn't think of when his pay check was coming in. Why should any man who has been in this association for 20 years, be dropped from membership when he becomes retired, on account of his unwillingness to incur the little expenses which he feels that he ought to cut out for the time being? I think we ought to vote for the bestowing of life membership on every man who has been a member for five years and becomes retired from service on account of age.

A. S. Markley:—I don't believe a man ought to be retired until he wants to be. When I am retired I want to know about it. I want you to have my consent before you do it. I am neither pensioned nor have we any old age list on our road. I expect to work there just as long as I can.

C. R. Knowles:—I don't know whether I am out of order, or not, but I would suggest that this matter be left to the executive committee, because I don't think we are going to get anywhere on the floor of the convention. I make that motion.

Chas. Ettinger:—Our Constitution provides that we can elect life members. Our membership has now reached a point where we can, I believe, fairly well afford it. One certainly will not refuse the honor that may be conferred on him, and it is an honor, conferred upon the old member, which he justly deserves, just the same as the pension is conferred on the man who has served in the ranks on the railroad. I believe that we should not do it for one. Don't take a few. Don't say to the executive committee later on, " You have done it for this man, but not for the others." Let the assembly act as a whole, right now, and confer the honor on one and all. (Applause.)

L. Jutton:—I move that we elect Mr. Charles Wehlen of the Long Island a life member. (Motion seconded and carried.)

G. W. Rear:—I move that we also confer life membership on every other retired man. (Seconded.)

L. Jutton:—It seems to me it would be a small matter for this association to consider every suggestion for life membership that comes up. I believe we ought to consider each one individually on its own merits.

G. W. Rear:—I would like to inquire on what basis each individual is going to be considered. Is it going to be on the recommendation of some person who comes in here with the interest of this other man at heart, or is it going to be put up by some man who is not represented here? It may be that a man out in some isolated quarter makes this recommendation, and he may be so far away, and so isolated, that we know very little about him. We lose the membership because that man has no one here to support him and make the motion that he be put on the life list. I request that a vote be taken on my motion.

E. T. Howson:—This question comes up each year. The discussion we have had this morning indicates there is a great deal of personal feeling and personal pride involved in this discussion. As a suggestion for a means of handling this, it would seem to me that it would be advisable for a letter to be sent to each member by the secretary, with other communications annually, before the convention, asking the members to suggest those who they think should be entitled to this honor; then that same officer of the association, either the executive committee or the secretary, communicate with those who are eligible and who have been suggested to find out whether this action meets with their desire. After having that information, the name would be brought before the convention directly, or the executive committee itself could put the question before the convention. In that way we would not have recommendations made that are not in harmony with the member's wishes, and at the same time avoid any embarrassment. That will give the honor in any case where it is deserved.

L. Jutton:—I think Mr. Howson's suggestion is very good. As a matter of fact, I fear Mr. Rear's motion would mean a change in our Constitution.

E. L. Sinclair:—In seconding Mr. Rear's motion I thought we were in harmony with the provisions of the Constitution, which automatically conferred life membership on anyone who was retired. I thought the motion simply put that provision of the Constitution into effect.

W. M. Camp:—It happens that I find that some men are a little sensitive about being called "retired men." I have unwittingly run up against cases of that kind where a man had been retired from railroad service and didn't care to have it advertised, and I believe there are men in this association who would rather not have life membership forced upon them. I think this is a subject that ought to be laid over for a little while. Mr. Rear's motion would automatically make life members of all those who are retired up to the present time. As for those who might be retired during the coming year, there is no provision for them. Those who are retired from railroad service necessarily fall into that class. I think this matter ought to be laid over, and that the executive committee discuss the various phases of it, so that it can be taken up another year for consideration. Perhaps by that time it might be considered the proper thing to make life members of all men automatically, as soon as they retire from railroad service, but I think the information first ought to be ascertained whether that would be the desire of all men who are retired from railroad service. I actually believe there are some who would prefer to remain active members of this association.

P. J. O'Neill:—I consider it an honor to be placed on the honorary membership list of this association. I believe that all of the old members will consider that we have been honored by the association by being placed on the honorary list of life members. A young man can't talk on this subject intelligently; he hasn't reached the age yet when it stares him in the face. I believe that I can talk for all of the old members, that they will feel it an honor that has been conferred upon them. They can attend the meetings and have all the rights and privileges they have always had. Where are you curtailing any of their rights and benefits?

R. H. Reid:—I move the question be laid on the table. Seconded by Mr. Knowles.

P. J. O'Neill:—If you find that motion is carried, that ends it.

R. H. Reid:—It is evident that this discussion would run on indefinitely. The motion to lay it on the table is not subject to debate. The question can be taken from the table later, after it has had further consideration by the membership.

P. J. O'Neill:—A motion laid on the table is killed forever, according to parliamentary procedure.

On rising vote the motion to lay on the table was carried.

The Chairman:—There is just one duty I want to perform before we come to adjournment. I would like to introduce to the new members the newly elected officers for this coming year. We will do that briefly by just asking them to stand in their places. (The new officers are introduced by the chairman.)

As our time is getting short, we will adjourn this meeting. I hope you will all boost for the convention at Atlanta.

Final adjournment at 11:00 a. m., Oct. 23, 1919.

C. A. Lichty, Secretary.

(Reported by LeRoy W. Hoskins on the Stenotype.)

CHARLES DALE

Charles Dale, supervisor of water service of the Illinois Central at New Orleans, was born at Gram, in the German Empire, January 9, 1871, and died at New Orleans February 9, 1919. He served in company E of the second regiment of United States volunteer engineers during the Spanish-American war and was honorably discharged from Camp Columbia, Cuba, April 14, 1899, his service record having been marked, "Excellent service, honest and faithful."

Charles Dale

At the close of the Spanish-American war Mr. Dale entered the employ of the Illinois Central railroad and served in that connection until his death, having been supervisor of water service during the last 12 years of his life.

Mr. Dale is survived by his widow. He was a prominent Mason, having been a member of several of the higher orders. He became a member of the Association at the time that the convention was held at New Orleans in October, 1916.

Z. T. BRANTNER

(By W. L. Stephens)

Zachariah Taylor Brantner, superintendent of the Baltimore & Ohio shops, at Martinsburg, W. Va., died at his home, 518 West Burke St., October 27, 1919, after a brief illness. Being possessed with a strong and rugged constitution and exerting the strong fighting qualities that had carried him so far along the road to success, he resisted the encroachments of disease and made a determined but losing fight against death.

Mr. Brantner was born near Martinsburg, W. Va., over 71 years ago and spent his boyhood days in and around this city. His early education consisted of such as could be obtained from the meager facilities existing in his home city at the time of his boyhood. Upon this small educational foundation, he, in after years, by close observance, careful study, and much reading builded a long and wonderful life of practical efficiency.

On January 1, 1863, at the age of 14 years he entered the employ of the Baltimore & Ohio Railroad as water boy in the maintenance of way department at Martinsburg, W. Va. Later he became a track hand. On February 1, 1864, he entered the machinery department as car oiler. On August 1, 1865, Mr. Brantner was made machinist apprentice under William Edwards, then master mechanic at this place, completing his apprenticeship in August, 1869. He was made gang foreman on locomotive overhauling in 1870. Continuing the upward trend he was promoted to foreman and transferred to the Valley Division in July 1874. After 12 years of conscientious service he was promoted to general foreman in December, 1886, and transferred to the Philadelphia Division. In May, 1891, Mr. Brantner was transferred to the Baltimore Division and placed in charge of the new shops in Brunswick, Md. On December 1, 1905, he was transferred to the maintenance of way department and placed in charge of the Martinsburg repair shops, thus returning to the place of his entering the service of the railroad company, and to the same department in which he started his long railroad career. Upon returning to the maintenance department he immediately set about familiarizing himself with its requirements, and at the time of his death had acquired a thorough working knowledge of all maintenance necessities. The splendid record made by the shop under his supervision was largely due to his broad vision, keen foresight and exceptional executive ability.

Z. T. Brantner

On December 31, 1912, he was presented with a gold medal by the president of the Baltimore & Ohio Railroad in honor of his having attained a half century's service with the company. The presentation was made by A. W. Thompson, the vice-president. At the same time he was promoted to the position of superintendent of shops.

This year he had entered his 56th year of service with the Baltimore & Ohio, and during all these years he had never lost a day on account of sickness until October, 1890, when he suffered the loss of four fingers on his left hand while clearing a wreck on the Philadelphia Division.

Mr. Brantner was a thorough, efficient, and loyal railroad man. He knew the railroad game in all its branches and played it with a zest that never seemed to fail. In active service of the same company nearly 57 years is a record seldom equalled and tells its own story of competence and worth.

He had been a member of the relief department for nearly 40 years and took great interest in its welfare. On his advice many employees purchased and now own their own homes. He organized the local lodge of the Veteran Employees' Association and had been its presiding officer since its inception.

In addition to his numerous railroad duties the deceased took particular part and delight in religious work and became a local preacher of much ability. All civic affairs, Y. M. C. A. work and fraternalism were subjects of the deepest interest to him. He became a member of the American Railway Bridge and Building Association in 1912, when the convention was held at Baltimore, and he took an active interest in its affairs.

WILLIAM SPENCER

William Spencer was born on October 3, 1845, in Lisbon, Kendall Co., Ill., and died at the National Sanitarium at Hot Springs, S. D., June 2, 1919, where he had gone a few days prior in search of treatment for heart trouble. He spent his boyhood days in the vicinity where he was born, receiving only a common school education. He took up farming in Kansas in an early day but lost all he had in the 70's during the grasshopper plague, and left the country on foot.

He entered the employ of the Chicago & Northwestern as a carpenter on the Galena division in 1885, and went to Chadron, Nebraska, in 1892, where he became superintendent of bridges and buildings of the Black Hills division of the Fremont, Elkhorn and Missouri Valley, now a part of the Northwestern Line. He held this position until he was pensioned in 1916, except two years, 1906-07, when he was engaged in the capacity of superintendent of construction on the Wyoming & Northwestern, a subsidiary line of the Northwestern, reaching from Casper to Lander, Wyo., a distance of 150 miles.

After being pensioned Mr. Spencer and his wife traveled extensively, the winter of 1916-1917 being spent in the vicinity of Miami where they were in constant touch with the Noons and "Deacon" Patterson. Mr. and Mrs. Spencer were on the Pacific coast during the war and while there he was engaged most of the time on ship construction at the Seattle and Portland shipyards.

Mr. Spencer was married to Marie Nolan, of Belvidere, at Chicago in 1888. He is survived by his widow, a brother, Thomas Spencer of Pueblo, a sister, Amelia Eccles of Tacoma, Wash., and a daughter, Mrs. Roy Bowers of Chadron. Interment took place at Greenwood cemetery at Chadron.

Mr. Spencer was a member of the Masonic fraternity and had been a member of the American Railway Bridge and Building Association since 1908, when the convention was held at Washington, D. C.

WILLIAM G. HICKS

William G. Hicks was born in Brooklyn, N. Y., June 8, 1879, and died Dec. 11, 1918 as a result of hardening of the arteries.

Mr. Hicks was in the employ of the Long Island Railroad for about 15 years, during which time he filled various positions in the maintenance of way department. At the time of his death he was in charge of labor distribution, and was also Liberty bond agent for the maintenance department.

He was married on June 23, 1898, to Martha Abrams of Rockville Centre. She was an invalid for about 14 years and preceded him in death about two years.

Mr. Hicks was active in civic and social affairs in Rockville Centre where he lived. He is survived by his father and mother (Mr. and Mrs. Charles N. Hicks), and his daughter, Vera G. Hicks. He joined the Association in 1916.

JOHN B. SHELDON

John B. Sheldon was born at South Kingston, R. I., on September 24, 1857, and died of heart trouble at his summer home at West Kingston on July 2, 1919. He had been in poor health for more than two years although he was able to carry on his work until the day before his death.

Mr. Sheldon entered the employ of the New York & New England railroad in the bridge department in 1881. After three years' service there he became bridge foreman on the New York, Providence & Boston, now a part of the New York, New Haven & Hartford. In 1901 he was appointed supervisor of bridges and buildings of the Providence division of the New Haven road with headquarters at Providence, and continued in that position until the time of his death.

Mr. Sheldon was married about 35 years ago to Nellie G. Brown of North Kingston. Their home for many years has been at Arlington, which is a suburb of Providence, but a part of the summers during the past 10 or 12 years were spent at West Kingston. Besides his wife he is survived by a brother, William S. Sheldon, who is employed by the New Haven road at India Point.

John B. Sheldon

Funeral services were held at the Queen's River Baptist church, Usquepaugh, South Kingston, in the community where he spent the earlier years of his life; this church building having been designed and erected by Mr. Sheldon several years prior to his death.

Mr. Sheldon served as a member of the school board of the city of Cranston four years, and on the Arlington public library board. He was a member of the lodge of the United Order of the Golden Cross, in Woonsocket, and a member of the American Railway Bridge and Building Association, having served as president of the latter organization in 1906.

W. M. NOON

W. M. Noon was born in Merton, Wis., on June 28, 1846, and died at Miami, Fla., on April 27, 1919. When 21 years of age he was engaged as a subcontractor in cutting wood for fuel for locomotives on the Chicago, Milwaukee & St. Paul road. In 1868 he went to Iowa, where he was employed for several years in various capacities by contractors on railroad construction work, after which he took up construction work on his own account, his specialty being bridge building. One of his important projects for the Chicago, Milwaukee & St. Paul was the construction of a drawbridge across the Kinnickinnick river at Bay View in Milwaukee on the line between Milwaukee and Chicago. Mr. Noon continued work on this road for nearly 10 years, going with the Chicago & Northwestern in 1884, when, after two or three years, he went with the Fremont, Elkhorn & Missouri Valley. From this road he went with the Duluth, South Shore & Atlantic in 1889, where he occupied the position of superintendent of bridges and buildings until August, 1912, when he went to Jacksonville, Florida, where he was engaged for a time in concrete construction work. A year or two later, while in charge of the reconstruction of some railroad trestle in Florida, he sustained severe injuries in the collapse of a scaffold, upon which the carpenters were at work, from which accident he never fully recovered. Not being further able to prosecute work in the line in which he had been so actively engaged for so many years, he moved to Miami, Florida, in 1915, where, with the aid of Mrs. Noon, he conducted a small notion store on Avenue G, until the time of his death.

William M. Noon

Although quite feeble, Mr. Noon was able to be about nearly every day. The evening prior to his death he was crossing the street near his store during a heavy rain when he was struck by a policeman's auto, which resulted in fatal injuries.

Mr. Noon was a prominent Mason and the funeral was in charge of Biscayne Bay lodge and Syrene commandery at Miami. He joined the American Railway Bridge and Building Association at the second annual convention held at Cincinnati in 1902.

W. E. ALEXANDER

(By Moses Burpee)

W. E. Alexander, superintendent of bridges and buildings of the Bangor and Aroostook, died at the Eastern Maine General Hospital, Sunday afternoon, Oct. 5, 1919, as the result of injuries sustained near Stockton Springs, Sept. 30, when the motorpede he was riding was derailed.

Mr. Alexander was born at Fredericton Jct., N. B., Dec. 17, 1848. He was married to Jennie Taylor, of Grand Falls, N. B., who died Jan. 25, 1913. Two sons survive, Burpee, who served as lieutenant in the Canadian Pioneers in France, now of Bear River, N. S., and Lieutenant William H. Alexander in the Naval aviation service attached to the U. S. S. Shawmut, now at Philadelphia.

W. E. Alexander

In earlier years Mr. Alexander was for some time with the Chicago, Milwaukee & St. Paul, and several years with the United States government, engaged in building dams on the upper Mississippi. Later he returned to New Brunswick to take charge of bridge work on the New Brunswick Railroad, and when the road was leased by the Canadian Pacific he remained with the latter company for several years. In the winter of 1893-94 he went to Maine, where he was engaged with the contractors in erecting steel and temporary wooden bridges for the Bangor & Aroostook until the railroad was completed to Caribou in 1895. For a short time he was employed by the late Thomas H. Phair in starch factory repairs.

In 1897 Mr. Alexander entered the employ of the Bangor & Aroostook and located at Houlton, Maine, where he became an American citizen. He was a deacon of the Houlton Free Baptist church, a constant attendant and untiring worker in support of its services. He belonged to Monument Lodge F. & A. M. of Houlton, and had been a member of the American Railway Bridge and Building Association since 1901.

METHODS OF BRIDGE INSPECTION UNDER PRESENT CONDITIONS

Report of Committee

The report of the committee on Subjects was dated October 15, 1918, and included among others the subject herein treated. It seems quite likely to the members of this committee that the subject assigned was suggested by the then present conditions which involved perhaps different treatment while the nation was in a state of warfare than conditions which now prevail in the readjustment period following the signing of the armistice on November 11, 1918. Conditions are even now considerably different than at the time of the assignment of the subject to the committee, and they are constantly changing day by day. It is therefore difficult to make an analysis with any degree of assurance that the report will be representative.

There are, generally speaking, two kinds of inspection of bridges, one for the detection of defects involving immediate safety, and the other for the detection of waning serviceability. We assume that since the first is primarily a matter of constant patrol of the railway lines, the second is to be the subject of our investigation. What is herein contained pertains exclusively to the matter of inspection as involved in current maintenance from year to year.

To prepare any information of value to the members of the Association, it was necessary to canvass the situation thoroughly with regard to the different methods of inspection in vogue throughout the country. Accordingly, a questionnaire was circulated under date of February 23, 1918, a copy of which appears in Appendix "A." To this questionnaire only 40 replies were received, involving about 90,000 miles of road, although it was sent to 100 different railroads.

The illusive character of the subject rendered it imperative to secure as much detailed information as could consistently be requested, which necessity in turn required a rather involved set of questions. The wide expanse of the country traversed by our railways suggested the thought that perhaps the methods of bridge inspection might be influenced somewhat by climatic or meteorological conditions, and therefore carriers were asked, in replying to the questions, to name the mileage by the states to which the replies were applicable. This would enable the committee to determine readily whether or not the geographical position of the lines reflected any definite influence in the method of inspection in use.

It was surmised at the outset that inspections were conducted by persons of various official rank and title, and accordingly it seemed necessary to ask for information as to this particular phase of the matter.

Another very important detail in the matter of bridge inspection is the method by which the inspector traverses the property; hence the inquiry as to the means of locomotion for the inspection party.

There are various tools and kinds of equipment which can be used to facilitate the actual work of the inspection, and an inquiry was made as to this phase of the matter in an effort to assemble data pertinent to the kinds most generally in use.

One of the most important features in connection with a bridge inspection is the means which the inspector uses for recording the results of the examination. Therefore an endeavor was made to assemble all the available forms which are customarily used for the purpose. An effort was also made to secure information as to the minuteness of the inspection as well as to determine the precise methods used in prosecuting the actual details of the work.

Then there naturally follows an inquiry into the disposition of the findings of the inspector. This of course involves a determination of the matter of handling the inspector's notes, when and how his recommendations are carried out and the governing factors which are made the basis of his recommendations.

Finally the committee was desirous of receiving any suggestions as to the whole matter of bridge inspection as viewed by the officers reporting for their respective lines.

Replies to this questionnaire immediately indicated that not only the methods in general, but the disposition of the inspector's notes and compliance with his recommendations were widely different for the two classes of bridge structures, metal and wood. It is therefore proper for us to report our findings separately for these two general classes of bridges, based upon the assumption that the classification of wooden bridges is constituted by wooden trestles and that the inspection of wooden truss bridges requires treatment very similar to that of metal truss spans.

Metal Bridges

While climatic conditions do have a very material effect on the durability of metal bridges, yet from the replies received, no general statement can be made that territorial location is responsible in any way for the methods used in inspection. It is unfortunate that the replies received by the committee do not state definitely that the frequency of inspection of metal bridges differs from that of wooden structures. This was probably due to an oversight of the committee in not asking specifically for information as to the frequency of metal bridge inspection in distinction from that of wooden bridges. It can, however, be stated generally that an annual inspection of metal structures is more generally in effect than that of any other periodicity. It may also be stated that the officer conducting the inspection of metal bridges is more frequently chosen directly from the staff of the chief engineer than from any other group of officers.

The motor car seems to be decidedly the most common means of locomotion for the inspection party.

As reported to the committee, the inspection tools for metal bridges consist generally of rivet hammers, calipers, rules and tape measures.

By far the greater number of railways and the greater portion of the mileage represented in the replies to the committee report the use of regular forms for taking and recording notes in the field. These forms are so diversified in character and extent that their presentation to the Association as a body is not possible. It may suffice to say that they range from ordinary mimeograph forms to bound note books. Some require notes to be taken in detail, others contemplate the record being made in narrative form. Many of them seem to cover the matter very comprehensively, while others are painfully lacking in provision for making the requisite notes adequately.

In the absence of regular forms for the purpose, the manner of making the notes is about as diversified as were the replies from those railroads which have no forms.

With metal bridges, as is to be expected, by far the greater number of railways operating make inspection separately for the various members.

As to whether actual measurements are taken to determine the amount of deterioration or decay, or whether such determination is based on general appearances in judgment, the replies received were unfortunately not specific as to whether they were applicable to metal or wood. It is probable that in most cases in the inspection of metal bridges, the general appearance and judgment of the inspector is the criterion as to whether actual measurements are necessary.

A decidedly major portion of the replies indicate that recommendations as to repairs and renewals are made at the time of inspection and are recorded with the notes, but in the case of metal bridges, it is more than likely that such recommendations are appended to the inspector's report after mature consideration of the conditions reported.

We find that in most cases the inspection notes are copied before being filed and that disposition of the notes is extremely diversified. No general practice regarding their disposition can be offered as representative of the majority of the roads. In some cases careful calculations are reported as being the method of determining changes in the carrying capacity of the structure, but in other cases no such calculations or other investigations are customary. Almost all carriers report the practice of comparing records of previous inspections with conditions found in an effort to determine the progress of deterioration.

Replies to the questionnaire apparently warrant the statement that on almost all roads the inspector has authority to order repairs or replacements, but we are inclined to believe that this authority is customary only with wooden bridges, since the repair, reinforcement or replacement of the metal structures is ordinarily the result of a definite program of elimination or reinforcement and therefore cannot, on account of its being a matter of policy, be delegated to the inspector. We are, however, justified in making the statement, at least with respect to metal bridges, that the practice of making recommendations to some other officer is more general than any other method. A few roads report the maintenance of an established system of determining by prescribed limitations in stress as to what action should be taken on the inspector's recommendations. This cannot, however, be said to be the general rule.

While different courses of movement of the inspection reports are described in the replies, it may be said that before definite action is taken their consideration is strictly a matter for the bridge engineer with whom the reports are finally lodged.

Few, if any, special forms are used in reporting to superior officers the results of the inspection as embodied in the field notes. The committee received meagre suggestions as to the matter of the general conduct of the inspection and the best way of securing the requisite results therefrom.

Wooden Bridges

Entirely different results are to be expected from the effects of climate on wooden bridges than with metal structures. From the replies received, we are unable to formulate any definite statement as to the general effect of climatic conditions in the periodic inspection of wooden bridges. Railroads in the same territory differ as to the frequency of inspection. A tabulation of the returns shows the periodicity of inspection and the percentage of the total mileage reporting under that periodicity as follows:

Annually	41.55 per cent
Semi-annually,	32.22 per cent
Three times annually	5.95 per cent
Four times annually	2.62 per cent
Six times annually	13.11 per cent
Monthly	4.55 per cent

Much difficulty is experienced in harmonizing rank and authority with the titles of officers on the various roads in the country. This is especially true with respect to those officers having authority in the bridge and building department. The most frequently used titles are bridge engineer, superintendent B. & B., supervisor B. & B. and master carpenter. Perhaps we are justified in stating that the officer most often made responsible for bridge inspection is either the supervisor or superintendent of bridges and buildings.

Nearly 75 per cent of the mileage represented in the replies customarily uses the motor car as a means of conveying the inspection party over the line, while only about 21 per cent uses regular or special trains.

The tools generally used for the inspection of wooden bridges consist of a special inspection bar and testing auger, although in some cases a chisel and brace and bit are added to the tool equipment.

Regular forms for recording inspection notes in the field are used by 85 per cent of the mileage represented in the returns to the questionnaire. The condition of each member is recorded separately by lines aggregating about 70 per cent of the total mileage reporting, but we are inclined to believe this pertinent to metal bridges only. Actual measurements are reported as being taken by 52 per cent of the reporting mileage, while general appearance and judgment are used by the remainder, viz., 48 per cent. By far the larger portion of the lines record in the notes recommendations as to repairs and renewals at the time the notes are taken.

The committee desired particularly to obtain information as to the forms of field notes and their disposition after the inspection was completed. The results of our inquiry show that while 85 per cent of the reporting mileage use regular forms for the reports, there is no uniformity in the manner of handling the notes when completed or the final disposition thereof.

As was to be expected, by far the larger portion of the railroads replying to our inquiries make a practice of consulting and comparing previous inspection records in order to determine the proper recommendations for action in the matter of repairs and renewals. It is scarcely possible in the case of wooden bridges to determine with any degree of satisfaction by calculation a change in carrying capacity due to deterioration or decay of timber. Therefore, while several railroads report that computations are used in such determinations, we are of the opinion that this course applies more particularly to metal rather than to wooden structures.

General practice is about evenly divided as to giving authority to the inspector to order repairs or replacement in distinction from simply making recommendations as to these matters.

In consideration of the foregoing briefly outlined data received from the various railroads, a survey of the conditions confronting the nation during the past year and an analysis of developments which may reasonably be expected in the near future, the committee begs to submit its conclusions as follows:

Conclusions

(a) While the country was in a state of war, unprecedented conditions confronted the railways, and these conditions among other things necessitated extensive recourse to substitute plans, alternative methods and unusual expedients. Now that the war is over we find ourselves citizens of a nation with a greatly depleted treasury and a huge burden in the shape of a national debt of staggering proportions. There never was a time in the history of our people when there was so great a need of economic and careful management. It may be said without fear of contradiction that the greatest urgency of the times is for conservation of both labor and material in order that the demands for the production of the necessities of life and of the requisites for industrial and commercial enterprises may be met. It therefore devolves upon us as citizens to use to the greatest extent possible the means we have at hand for accomplishing useful purposes and thus conserve resources which in normal times might be used with impunity. In other words, it behooves us to get out of materials every vestige of use and serviceability which they possess. When the question of safety to life and limb is involved and protection against loss and damage to property is the governing factor, this conservation can best be obtained only by extreme vigilance in the way of careful and rigid inspection, for after all is said and done it is the behavior in service of men and materials which affords the final criterion for their replacement or renewal. We therefore believe that the matter of bridge inspection is one of the most important phases of work which confront us at the present time.

(b) We conclude that in addition to the patrol of railway lines for emergency hazards which are likely to present themselves at any moment, a systematic plan of thorough bridge inspection should be inaugurated on every railroad regardless of its extent. This inspection should not in any event be undertaken at more infrequent intervals than annually and preferably it should be made semi-annually. There are many cases in which, dependent upon the volume of traffic, material will serve for an additional period of six months when there is doubt as to its serviceability for a year. Accordingly as to whether annual or semi-annual inspections should be inaugurated, consideration should be given to the customary length of time ensuing between the date of inspection and that as of which the recommendations of the inspector can be carried out.

(c) Mention has been hereinbefore made of the diversity of duties and authority of officers having the same or similar titles with the various railway lines. We are, therefore, unable to suggest, at least by official title, the officer who should be designated as the person in charge of or responsible for the actual work involved in bridge inspection. Where the railroad is large enough to justify the maintenance of a regular inspection organization, then obviously the designation of the person to make the inspection of bridges is comparatively a simple matter. The difficulty is primarily to be found in roads of moderate size where an officer must be detached from his regular duties to take charge of inspection. For metal bridges a person particularly qualified by technical education and training should be selected, but in the case of wooden bridges where continued serviceability is not so much a matter of mathematical calculation, it would seem that a person of mature judgment and experience is highly desirable. Accordingly, without further suggestion, we leave open as a matter of preference for the individual lines the designation by official rank and title the proper officer for making the inspection.

(d) Since the actual field work connected with the proper inspection is necessarily slow and laborious, it is not only advisable but quite necessary that the best possible means of taking the inspection party over the line be afforded. Because of the expense incident thereto, the inconvenience of alighting from and boarding standard train cars, the abnormal consumption of time in stopping and starting, regular or special trains used for inspection parties do not meet the requirements, except perhaps in isolated cases where bridge structures are few and of unusual magnitude. The gasoline motor car appeals to us as very decidedly affording the best means of locomotion for the inspection party.

(e) Many inspectors have their pronounced ideas as to the kind of tools best suited for their work. We think that the preference of the inspector in this matter should be followed and that any special form or size of tool or equipment desired should be furnished without hesitation, even to the extent of having them made expressly for the purpose if necessary.

(f) There can be no doubt as to the necessity for regular forms designed especially for bridge inspection purposes. The cost of these is indeed trifling when compared to their inestimable value in insuring a satisfactory record. We believe that extensive study given to this phase of the matter will be amply repaid. It seems to us that just as in the case of inspection tools or in the method of conveying the inspection party over the line, every facility possible should be afforded to the inspector. Therefore, forms for the taking and the recording of notes in the field should be comprehensive and complete as to detail in order to assist the inspector in his work which at best is apt to be trying, if not in fact, exceedingly difficult. The taking of any kind of notes in the field is essentially a mental picture of observed material conditions, and any device which will serve to assist in the portrayal of actual conditions should be supplied. Accordingly we think forms not only complete and comprehensive in substance, but of convenient size and shape, necessary. We had hoped to receive among the various samples submitted to us at least one form or set of forms which we could recommend for adoption. In this, however, we were disappointed, and of all those received, we cannot consistently suggest any as a model. As a result we conclude that each railroad should make a study of its own particular conditions, its form of organization and its customary method of handling such matters and then as a result of this study design special forms to suit its requirements. It will be apparent that on account of different inherent characteristics, the forms for metal bridge inspection require different treatment than those for the inspection of wooden structures. We think it therefore proper to advise the adoption of separate forms for these two classes of structures.

A decided advantage is secured in having notes made in manifold in the field, thus obviating the necessity of transcription in the office and still preserving the distinctly desirable feature of having both the inspector and his superior officer supplied with an exact counterpart of the record as it was made in the field. However, if it should be deemed impracticable or apparent that the taking of the notes in manifold will in any considerable degree embarrass the inspector in the actual work or impede the progress of the inspection, then manifold copies should be foregone. In addition to forms for the actual taking of inspection notes and the recording thereof, we also suggest for thorough consideration the advisability of specially designed forms for the transmittal and summarization to superior officers of the results of the inspection, and such forms we believe will prove valuable in the preparation of a working program of repairs, renewals and replacements.

(g) Since it is difficult to perform simultaneously the actual details of investigation, such as sounding, tapping, boring or measuring in the different parts of the structure and to record the results in the notes, we conclude that the inspector should be accompanied by such assistants as may be necessary to effect a rigid examination. These assistants need not necessarily be officers and can usually be selected from the employés of the bridge and building department. About the only requirements for competent assistants are normal physical activity and average intelligence and alertness. We suggest that such method of inspection be pursued as will reveal beyond all question the exact condition, and to this end any testing, calculation and measurement necessary should be made.

(h) It is difficult to account for the fact sometimes observed that one member of a bridge is in a different condition from a similar member of equal age and identical character of material. If this fact prevails to any great extent, then we are of the opinion that the condition of the members should be reported separately, but otherwise they can just as well be reported by groups or classes. We are unable to advise further in this phase of the matter because of the fact that, especially in the case of wooden structures, the different groups or classes of members are usually constructed of different kinds of timber and also because of the fact that there is a great diversity in the practice of effecting repairs and renewals on the various railroads.

(i) With metal bridges it will probably be necessary to make actual measurements for the determination of waning serviceability, especially if there is reason to believe that deterioration had to any extent taken place since the previous inspection. Measurements are particularly necessary in the case of a structure which is nearing the point of retirement on account of age, deterioration or over stress of material approximating permissible limit of stress for such material under actual load. In the case of wooden bridges, we are unable to see how measurements carefully taken are always warranted, for usually the waning serviceability of timber is a matter of approximation, experience and judgment. Consequently our views as to this are that the experience and judgment of the inspector should be given the greatest weight in considering the adoption of his recommendations.

(j) The distinct advantage of having the inspector record his recommendations as to repairs and renewals at the time of the inspection is apparent. We therefore suggest that this practice be made universal. We also believe that logical recommendations cannot be formulated without consulting with previous inspection records. This, however, would seem to be a matter of personal fitness of the inspector, and the practice should be cultivated, for what has taken place in the past must necessarily afford some idea of what may be expected.

(k) The authority of the inspector should be broad enough to include the prerogative of ordering immediate repairs through the nearest responsible officer in case the exigencies of any particular case warrant such action. This would of course only result from the discovery of a condition too hazardous to continue unabated until corrected with the customary program of repairs and renewals. Ordinarily, however, the policy of the company or form of operating organization will dictate that recommendations of the inspector be made to the officer in charge of the maintenance of bridges and culverts, if the inspector himself is not that officer.

(l) We do not see how any prescribed limitations in stress under actual loading can be inaugurated for determining the amount of repairs and renewals in the case of wooden bridges, for there are no data extant showing definitely the strength or dependability of timber as influenced by age or state of decay. With metal bridges, however, the question is entirely different and it is our suggestion that if possible to do so, each railroad establish certain limits in stress beyond which loading must not be increased in their production. This is properly a function of the bridge engineer and no general rule can be suggested at this time for adoption by the different lines.

(m) The committee believes that the program and general conduct of inspection should be left to the discretion of the individual railway, but we strongly favor the recording of all inspection data in the field at the time of the actual investigation and that these data be used for all desired purposes without their transcription or copying if possible. We also strongly favor the plan of having a counterpart of all notes, reports and recommendations filed in their original form in the inspector's office in such a way as to be readily accessible. In any event, all papers and records in any way connected with the inspection should rest finally in some one office file so that all the facts pertaining to any phase of the matter can be produced without the expedient of consulting more than one record file.

These conclusions may be summarized and enumerated in the form of recommendations thus:

1. A well organized plan of thorough and periodical bridge inspection should be in effect on all railroads. Inspection should preferably be made semi-annually and in any event not more infrequently than annually.
2. The inspector should be particularly fitted by training and ex-

perience for the work, technical education and training being requisite for metal bridges and both judgment and experience for wooden structures.

3. Motor cars afford the best means of conveying the inspection party over the line.

4. Such tools, either special or standard, as he may consider useful for his purpose should be furnished the inspector.

5. Special inspection forms for taking and recording notes are essential. Adequate provision should be made for reporting the condition of bridge members individually or by groups and classes, dependent upon the facts disclosed by the examination.

6. Sufficient assistance to insure the thorough and comprehensive examination of structures inspected should be supplied.

7. Where necessary to determine the extent of the deterioration, actual measurements of members should be made.

8. Recommendations of the inspector as to corrective measure which should be applied to observed conditions are not only desirable but practically necessary. These recommendations should be recorded in the notes at the time of inspection and upon its completion should be followed up through proper channels for necessary action thereon.

9. The inspector should be vested with authority to order through proper channels the correction of any imminently unsafe condition discovered.

10. Prescribed limitations in stress should, if possible, be established, especially for metal bridges.

11. The general program of inspection can best be formulated by the individual railroad and must needs be developed by a consideration of the operating organization in vogue, methods of effecting repairs and renewals and the number, magnitude and character of bridges maintained.

12. At least one complete counterpart of all notes, recommendations, records and papers pertaining to the inspection and corrective measures applied as a result thereof should be kept in one file of ready access.

Respectfully submitted,
Arthur Ridgway,
J. S. Huntoon,
J. H. Johnston,
Herbert C. Keith,
G. W. Rear,
J. L. Winter,
Committee.

In subscribing to the foregoing report Mr. Keith states that—

Although accepting in the main the report as submitted to the committee for approval, he must take exception to the opinion expressed in the preamble under the heading "Wooden Bridges," where it says "it is scarcely possible in the case of wooden bridges to determine with any degree of satisfaction by calculation a change in carrying capacity due to deterioration or decay of timber. Therefore, while several railroads report that computations are used in such determination, we are of the opinion that this course applies more particularly to metal than to wooden structures"; and to the conclusions drawn therefrom, expressed in paragraph (c) that "in the case of wooden bridges—continued serviceability is not so much a matter of mathematical calculation." Mr. Keith maintains that it is as simple a matter to determine the capacity of timber structures as that of those made of steel or iron. Accordingly, he thinks that Recommendation 10, that the limitation of stress should be prescribed, might apply equally to steel and timber.

He also objects to the conclusions drawn from these assumptions and their limitations as expressed in paragraph (c). "For metal bridges a person particularly qualified by technical education and training should be selected, but in the case of wooden bridges where continued serviceability is not so much a matter of mathematical calculation, it would seem that a person of mature judgment and experience is preferable." Also to the limitations under Recommendation 2. He believes "that the Inspector should be particularly fitted by training and experience for the work," and that technical education and training, and also judgment and experience are requisite for both metal and wooden structures.

APPENDIX "A"

THE AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION

Denver, Colorado, February 23, 1919

Dear Sir:

The committee appointed to submit at the next convention of the Association a report on "Methods of Bridge Inspection Under Present Conditions" earnestly request your coöperation to the extent of responding to the following questions.

It will be quite satisfactory to send direct to the Chairman replies numbered to correspond with the question without repetition thereof in your response.

1. Name of Railroad.
2. Roughly approximate mileage by states to which replies are applicable.
3. How frequently are bridges inspected? If not continuously state time of year inspections are made.
4. Official title or rank of officer in charge and number and kind (Class of Employé) of Assistants in inspection party.
5. State method (means of locomotion) of conveying inspection party over line.
6. What inspection tools and equipment are used?
7. Are regular forms used for taking and recording notes in the field? If so, please send copies.
8. If no regular forms are used please state usual manner of making notes especially with reference to:
   (a) Location, Type, Span and General Information;
   (b) Substructure;
   (c) Superstructure;
   (d) Floor.
9. Is condition of each member recorded separately, or all of those of a kind grouped and recorded as a class?
10. What methods of inspection are used? (Give such details as may seem desirable.)
11. Are actual measurements taken to determine amount of deterioration or decay, or is such determination based on general appearance and judgment?
12. Are recommendations as to repairs and renewals made at time of inspection and recorded with the notes?
13. Are inspection notes made in manifold or copied, and in what office are they filed? (State customary disposition and advise if used in succeeding inspections.)
14. What calculations or other investigations are made to determine change in carrying capacity due to deterioration or continued service?
15. Are comparisons made with previous inspection records to determine progress of deterioration or waning serviceability?
16. Does inspector have authority to order repairs, reinforcement or replacement, or does he make recommendations to some other officer, if so, to whom?

17. Do you have an established system of determining by prescribed limitations in stresses under actual loading or otherwise as to what repairs and renewals should be undertaken and if so please describe in full.
18. To whom are inspection reports made? (If any forms are used for this purpose please attach copies and if no forms are used outline character and extent of report.)
19. Please favor the Committee with any suggestions you may have which are not covered by foregoing questions. Your recommendations as to
    (a) Program and General Conduct of Inspection;
    (b) Collection and Recording of Inspection Data;
    (c) Disposition of Data, Reports and Recommendations;
    will be greatly appreciated.

Yours truly,
J. S. Huntoon,
J. H. Johnston,
Herbert C. Keith,
G. W. Rear,
J. L. Winter,
Arthur Ridgway, Chairman,
Assistant Chief Engineer,
Denver & Rio Grande R. R.,
Denver, Colorado.

DISCUSSION

(Methods of Bridge Inspection)

The Chairman:—Mr. Ridgway will open the discussion and give us a synopsis of the report.

A. Ridgway:—Mr. President, I want to acknowledge before the members of the association the consideration which the members of the committee gave to this subject. It was difficult to get opinions because we were scattered to the four corners of the earth, as it were—one in Canada, one in New York City, one in Florida, another on the Pacific Coast, one at Detroit, and myself at Denver. I wish to thank the members of the committee for the consideration which they gave to the report. I think that since you have before you the full report it will be unnecessary to read any portion of it.

Secretary:—Are there any important points that you ought to bring out?

A. Ridgway:—I am not sure whether the association ought to take any official action regarding the recommendations and conclusions in the report. I think perhaps that should be left to you. The note reporting some conclusions with which Mr. Keith could not agree, has been slightly changed. I believe that was printed before later advice had been received from Mr. Keith, and I am of the opinion that Mr. Lichty has a copy of that.

(Note: Mr. Keith's revised conclusions appear at the end of the report, just ahead of Appendix " A.")

It seems that this report has not been circulated very generally among the membership and it may be well to review briefly the vital points. The first step, of course, in our work was to canvass the situation in an effort to ascertain what methods of bridge inspection were being followed. Accordingly, a questionnaire was prepared, and this questionnaire appears at the end of the report. The situation with regard to bridge inspection was so complicated that it necessitated rather an involved questionnaire. It was sent to some 100 railroads on February 23. We received about 40 replies, representing about ninety thousand miles of railroad. We were disappointed in many of the things we started out to do. We found out that we could not classify the different methods. We could not recommend anything very definite because of the fact that there was so great a divergence of practice, and because of the fact also that it seemed that members might be constrained to follow recommendations, whereas the methods they were accustomed to using might be the best for their purposes.

Briefly, the first two or three pages discuss the replies to the questionnaire. The conclusions of the committee are drawn from a study of the situation, and also from the replies received. It was thought best to condense those conclusions somewhat in the form of recommendations for your use. What we hoped to do was to present something which you could use in your work. Perhaps we have failed. At least we have tried.

The Secretary:—If you have no objection, I would like to read the first page and a half of the report. I think it will help us in our discussion.

G. W. Rear:—Having had something to do with the preparation of this report it appears to me that it will be necessary to read all of it. It is an involved subject and it is not altogether clear in my own mind yet. Besides, those present have just now received copies. I don't think it is possible to discuss it or even get an intelligent idea of what is in it except by reading it.

(The report was then read.)

A. Ridgway:—We received some good forms and I am sorry that we cannot present them to you, but this association would have become bankrupt if we had tried to reproduce them. I don't believe there were any two alike, and I fear there weren't any more than two or three that followed the same general plan.

G. W. Rear:—As a member of this committee we found it very hard to get out any report at all. The committee was scattered all over the United States. Each one, of course, felt that he ought to do his share and it was only, really, when we got into some little arguments that we got any work done at all. There are some little technical details that all of us are not agreed on, but I believe that all did agree far enough to sign the report. For myself I do not agree with the division of the bridges between Metal and Wooden Bridges. We compromised on an explanation that a wooden bridge really meant a timber trestle, but some of us are still blessed with a large number of wooden trusses. We ourselves have over one hundred, with some spans over 200 ft. long. It would seem to me that the real line of demarcation that should actually be drawn is between truss and stringer bridges. We have iron and wooden stringer bridges and they are in a class by themselves. I believe that the iron truss and the steel and wood trusses all group around the same style of a bridge, and should be treated accordingly. I think that the sub-titles "Metal Bridges" and "Wooden Bridges" should be divided to read " Truss Bridges " and " Stringer Bridges."

R. H. Reid:—I think the distinction between metal and wooden bridges is good; it is natural. Wooden bridges are subject to different deterioration than metal. Wooden bridges deteriorate from the day they are completed, while metal bridges, if properly protected and painted, remain in practically a state of perfection for several years at least. After that time the wear and tear of traffic and a certain amount of deterioration that sets in, even in the face of painting and ordinary care, begins to have its effect on the metal. Of course, if metal bridges are not properly painted, deterioration starts at once, and progresses very rapidly. Metal bridges require a different kind of inspection from timber bridges. That is, an inspector may be competent to inspect and recommend repairs for timber bridges and yet he may not be competent to recommend repairs for, or make an inspection of, metal truss bridges. Ordinary stringer bridges, such as I-Beam stringers are, of course, in their conditions of service, somewhat similar to wooden stringer bridges. They do not have the complicated stresses, the rivets to get loose, pins to bend and break, and other things like that, but the composite metal bridges, trusses, lattice bridges, and things of that kind require higher experience and more ability than the inspection of the ordinary wooden trestle bridges. Wooden truss bridges require more careful inspection than wooden trestle bridges, especially if they are not covered. The web members of a truss and the chord members are peculiarly subject to decay. In a packed chord, especially if packed with wooden keys, water gets in and starts decay from the inside. I found on our own line that a wooden truss bridge might look good on the outside, yet, by taking a small auger and boring into the chords and into the packing keys and at the foot of the clamps, we found dry rot in certain cases. In some cases it was enough to warrant the elimination of the bridge. In the case of ordinary wooden trestle and wooden stringer bridges the appearance of the structure itself generally shows whether it needs repairs or renewal. There are times, of course, where you can't depend entirely on appearance. Caps on piles may look good on the outside, and have dry rot on the inside. Stringers may look good on the outside and have dry rot or wet rot on the inside. While to an experienced inspector the appearance of the bridge will go a long way toward telling its condition, it is not always infallible. Unless a man is thoroughly posted on each bridge on his territory, and actually knows the conditions, he must generally have to go beyond appearances in making a thorough and competent inspection.

G. W. Rear:—We have about one hundred wooden Howe truss bridges and they require much more inspection than any metal bridge that was ever built. They also require a high degree of technical knowledge as to just what a wooden truss is supposed to do. The wooden truss is the structure we have to inspect the most, and the most carefully; we not only have to inspect it for its physical condition but also for its capacity. About every three or four days we are called on to determine whether a certain type of locomotive can run over such a branch. The wooden truss bridge is a great burden on the man who has to maintain a large number of them.

The Chairman:—I believe that we all have pretty well defined ideas as to whether we ought to inspect our bridges once or twice a year, or oftener. Let us have your ideas.

C. W. Wright:—Twice a year or three times a year is not enough. I don't believe that you ought to have a bridge, particularly a wooden bridge or a truss bridge that is not inspected at least once every three months. It is the displacement of material as much as the decay. I believe that four times a year is not too often.

P. N. Watson:—On our road we have general inspectors who inspect bridges probably twice a year on the system, but I have men who inspect all bridges once a month. We have several wooden truss spans, a few pile bridges, and many steel structures. We also have several lattice wooden bridges, and if any members here can tell what they will carry today or next month, he can do more than I can, but we inspect them often and maintain them as near right as we can. I think that monthly inspection of such structures is absolutely necessary.

The Chairman:—How many inspections do you make a year to ascertain the work to be done on them in the shape of renewals and repairs?

P. N. Watson:—Probably two a year.

The Chairman:—The idea of your monthly inspections, then, is simply to be sure of keeping them safe.

A. Ridgway:—The committee's reason for putting that paragraph in was that the committee on subjects wanted us to report on methods of bridge inspection for current maintenance for repairs and renewals. We all know that our bridges are inspected more frequently than every six months or once a year, but this is the inspection to determine the year's program, as it were, for repairs and renewals. Almost every railroad has some kind of a budget, and it is necessary to have some idea as to the amount of work that is necessary for the next year in order to make up the budget. One can't get that by running out every two or three days and taking a look at the bridges. He has to have one real inspection, and at this inspection he must take enough notes, and secure enough information to make up the budget. Those who have had anything to do with the budget know that they don't always get on all the work that they expect to get, and that really ought to be on. Nevertheless, the inspection is the only basis that one has to make up the budget from. Consequently, I think that the recommendations of the committee ought to be allowed to stand in that the railroads of the country have their choice as to whether they will make this general inspection once or twice a year. Every road knows, of course, how often it can make it and what will suit them best. If there is no further objection, I will read the next section. (Reads Section c.) May I read Mr. Keith's exception to that? As I stated before, the notes at the end of the report do not apply as we have received later advice from Mr. Keith. Mr. Keith states that " In subscribing to the foregoing report, although accepting in the main the report as submitted to the committee for approval, he must take exception to the opinion expressed in the preamble under the heading ' Wooden Bridges,' where it says ' It is scarcely possible in the case of wooden bridges to determine with any degree of satisfaction by calculations a change in carrying capacity, due to deterioration or decay of timber. Therefore, while several railroads report that computations are used in such determination, we are of the opinion that this course applies more particularly to metal rather than to wooden structures.' "

Mr. Keith maintains that it is as simple to determine the capacity of a timber structure as of those made of steel or iron. Accordingly he thinks that recommendation 10 " that the limitation of stress should be prescribed " might apply equally to steel and timber. Steel is a metal and has little affinity for common chemical elements. Wood is a vegetable, susceptible to many structural changes after the tree is cut. Steel is manufactured and subject to inspection during the process of manufacture. Defects in growth of wood cannot be foretold accurately. Steel is uniform in structural characteristics. Wood is subject to so many natural and artificial conditions that any prediction as to its behavior can't be confined to very narrow limits. If at all, steel loses its strength through deterioration very slowly. On the other hand, from the moment the tree is felled deterioration starts and follows no regular or mathematically certain course; hence, the limits of stress for steel can be readily fixed within rather narrow bounds while the limits of stress for wood, even when new, are the average of a wide range of values. We all know that, being a homogeneous material, the remaining life or serviceability of steel can be readily determined. In fact, it is apparent. We say the net section is the same strength per unit as the original section; therefore the remaining serviceability left in steel is very evident from inspection. Wood is entirely different. The depth of decay in the stick is really no criterion for what is inside—what unit stresses the remainder of the stick will stand. We find also that the strength of timber varies for different species of wood, and even for different sticks of the same species. The season checks and other weathering developments exert an influence, and the position of the stick in the completed structure also must be considered. Those things are really as great factors in determining its carrying capacity as the depth of decay. Therefore we say that with all these complexities and inter-relations of defects, and the deterioration in the wood, the wooden structure is not as susceptible of mathematical demonstration as that of steel, so we don't advise prescribed limitations of stress for inspection purposes. To do this we think it would require really ultra-conservativeness, putting the stresses very low. If not, there would be some cases in which the inspection would result in passing it up and probably approaching very near the danger line.

F. E. Schall:—It seems to me this discussion needs to be based on the bridge inspection for the purpose of the annual budget and renewals. We are having a report here that doesn't cover the ground it is supposed to. The heading says " Methods of Bridge Inspection Under Present Conditions," but it doesn't define. That is simply a question of finding out how much money we will have to provide for next year's work. Now we will either have to change the heading or change the report in order to get it right. I personally take the position that the metal bridge, under certain conditions, will require just as much inspection as a wooden bridge. It all depends upon how much the bridge is overloaded over and above its original design. Where is the bridge located? How much has the salt brine eaten away the metal? Perhaps you may have to go to that metal bridge twice before you go to the wooden bridge. Now when I speak of a wooden bridge, I don't mean truss bridges. We find that we can usually help ourselves with a wooden bridge, but we find ourselves in a different position with a metal bridge when it is once over stressed to a point that is near the limit of safety.

The Chairman:—You think, then, that we should have a different inspection for metal structures than for wooden bridges?

F. E. Schall:—Not a bit. You can't draw a line. It depends on the traffic, on whether the bridge is overloaded, and on the design of the bridge as to whether it suffers under the load by its peculiar construction and limitations of that kind.

The Chairman:—Don't you think that the strength of a metal structure can be determined by calculations on the remainder of a section, whereas that is not possible with a wooden structure?

F. E. Schall:—You can figure those stresses down so far, and no further.

G. W. Rear:—We foresaw the very difficulty of which Mr. Schall is now speaking. You will find our position in the second paragraph, the opening of the report. We assume that this inspection is for waning serviceability and not for the detection of dangerous things which will arise probably in emergency cases. I think that farther along in this report we have probably covered this. We did come to the conclusion that for metal bridges there should be some absolute limit beyond which no load should be permitted to go, and that nobody could crowd one to go over that limit.

The Chairman:—Mr. Rear will continue reading the conclusions. (Reads paragraph 1 of conclusions.)

Maro Johnson:—The working season is limited to six or eight months. If there is an inspection in the fall to make up a program for the work starting the next spring, it is not clear when the work reported on in the spring inspection is performed. Of course, a bridge may deteriorate considerably in six months, but that feature can be taken care of by the monthly inspection.

G. W. Rear:—The committee has no objection, of course, to anybody inspecting the structures semi-annually or annually. The only idea was to express the opinion of the committee, and some of the committee thought six months was the proper period, although it would appear that an annual inspection is probably the most common. (Reads paragraphs 2, 3 and 4.)

The Chairman:—There ought to be some comment on the tools to use.

R. H. Reid:—On our line we use a pointed steel bar of ¾-in. round steel, with a point about two inches long on one end. On the other end is a knob, something like a door knob in shape, for sounding timber. We use the sharp end to get into the sap-rotten pile or timber, and the other end for sounding timber and piles which apparently are good, and yet sometimes may have dry rot on the inside. By striking the timber with the knob end of a bar of that size, you can tell if it is hollow or sound, and the experienced workman can tell about how much sound timber there is on the outside of the rotten inner core for the timber with a real thin shell will have a different sound than the timber with a shell of considerable thickness on the outside. We have also used a ⅜-in. auger for boring into the timber for decay which could not be detected readily by either a pointed bar or by sounding. Sometimes we bore into the chords to determine whether there is dry rot in the timber, when we couldn't tear the chord to pieces with a pointed bar, and couldn't always tell by sounding. Those tools are the ones that we have depended on entirely for our inspection of wooden bridges. For the inspection of metal bridges, and especially where there is heavy rust, we use the steel bar for scraping off the rust and determining how badly the structure is rusted, and sometimes we use the head of the bar for sounding rivets to determine if any of them are loose. If the riveted structure has been in use for any particular length of time a loose rivet will show itself by the red around the rivet. If any other part of the riveted structure, the steel angles, or any other parts are loose, they will show the rust from the working and churning of the steel. In a heavy steel bar sometimes one can't tell it, and the hammer is a good tool for breaking off the rust scale. That scale forms on metal bridges all the way from the thickness of paper to ½-in. I have seen rust scale on those bridges fully half an inch thick that has been allowed to accumulate for the lack of proper inspection.

(Mr. Rear reads paragraph five, and continues:)

I will venture to say if there are 160 men here there are at least 160 different forms, and probably none of them are ideal. The American Railroad Engineering Association got out some standard forms a few years ago, one of which is very good. After long experience in writing down inspection reports I have found the narrative form by far the best. I have examined all of those books where you mark down crosses and X's, and there is nobody except the man who writes them down who has any conception whatever as to what they mean. He may intend to say that the structure was new last year and do it in circles and squares, but for a man to write down the way it appears to him in the English language, without any shorthand, is the very best method. Then there can be no question about it, and if the inspection report happens to get into the hands of anybody else, he can see pretty nearly what it is.

On our railroad—and I think that is what ought to be done on all railroads—the inspection party inspects everything as they go along, whether it is a bridge, trestle, cattle guard, pipe or wooden box. They note on the inspection report that it is still there, and give some idea of its condition at that time.

We used to use forms with carbon copies. A man would have a pad fixed up with carbon copies and just about the time he wanted to write something on it he would find that the wind was blowing and he was at the bottom of the page, and he would have to change the carbon sheets. As a result we got up a book of another character.

G. W. Andrews:—I understood Mr. Rear to say that of the great number of inspection reports, probably one for each railroad represented here, none of them are good. We think we have a very satisfactory form. We don't care whether our form is satisfactory to anybody else, but we do know that it is satisfactory to us, and it keeps us in touch with the bridges. In explanation I might say that each of our divisions has one or more competent bridge inspectors. Those bridge inspectors are furnished with books of forms made just as simple as possible, and in which are given the bridge number, the date of inspection, and a column for remarks showing the character of the work or the condition in which they found the bridge. That is drawn up in triplicate, one copy of which goes to the master carpenter, and one to the division engineer. The division engineer enters it in a card index, of which we have three classes—for the wooden structures, for the steel bridges built before 1890, and for the steel bridges built since 1890. When anything extraordinary is found that requires attention from the general office or from the office of the engineer of bridges, in the way of strengthening, a monthly report is sent in, or, if found serious, a report is sent in immediately, when an inspection is made from either the office of the general superintendent of maintenance or from the office of the engineer of bridges, or usually by both. Plans are drawn, orders placed in the shop for the necessary material and it is fabricated and sent to the site where it is installed.

Mr. Rear reads No. 6, No. 7 and No. 8.

R. H. Reid:—On the New York Central the inspection is made by the supervisor of bridges himself. We have a bridge inspector on each division. The divisions run from about 400 to 900 miles. The determination of any repair and renewal work to be done is made following the general inspection trip of the supervisor of bridges which is made twice a year. We use a loose leaf book with 6 or 8 pages, 3¾-in. by 7-in. We have a bridge record written on that. We tried the typewritten form suggested by Mr. Rear, but while it is convenient for getting it out and multiplying the copies, it didn't make it so compact, and our inspectors and men generally preferred the smaller book, so they write up their own books, and I write mine. I write up my inspection book about once every five years, but I correct it after every weekly report and it is the official bridge record of the road for it is from that book that all our bridge calculations and our bridge history is secured. The inspection notes are made at the end of each sub-division for each branch. The records are written upon the regular pages and the inspection notes are made on single ruled sheets at the end. After each year the inspection notes are removed and filed, so we have a permanent file of inspection notes on our bridges for years back.

In connection with the valuation work the inspection records have been very convenient. Our valuation people have come to us time and again to find out what work we have done on certain bridges during certain years. The bridge record itself, as I said before, is written up about every five years, and the old records for the bridges are filed away, so they are always available as history. In my book the inspection notes for each division are always at hand, and are always carried in records of the previous inspection with it on the general inspection trip. We have the previous inspection record with us and in that way we have a follow-up system so that any defect that is noted in the bridge, if it is one that doesn't require immediate repairs, can be followed up on succeeding inspections and developments noted. In that way we can sometimes carry structures longer than would be possible with more infrequent inspection, and without the follow-up system of keeping track of defects.

C. F. Estes:—We have a somewhat similar system on the Union Pacific. We keep our notes in book form in the office where we have access to them. Anything that is found to be of an emergency character is done immediately on the supervisor's request. The other work is followed up very closely as soon as we can get the necessary authority. A record of each inspection is always kept in the office where it can be gotten at all the time.

The Chairman:—This paragraph has to do with the method to be used in getting the inspector's recommendation before the proper officer, and the resulting action.

A. Ridgway:—The idea in drafting that particular clause was just this: We all know that the man on the ground is the best man to make recommendations to correct the conditions which he has observed. His suggestion has greater weight than if anybody else made those recommendations. If he simply reports the conditions without saying what ought to be done, the supervisor or the man in charge is apt to lay out a program of work for that bridge slightly unnecessary or perhaps not sufficient to take care of conditions. It is really the man on the ground whose recommendations should be taken, and whose recommendations bear weight.

T. B. Turnbull:—I am talking from the standpoint of a small railroad because I am interested in a small railroad and am connected with one. I am the superintendent of bridges and buildings, the man who makes the inspection, and as it is only a short line—a little over 300 miles—of course one gets familiar with every structure on it. The superintendent of bridges and buildings has authority to make all repairs necessary to any bridge. He makes the inspection in the fall of the year, not only for the renewal of the bridges the coming year, but for any improvements that he thinks ought to be made. Improvements are only made upon the authority of the chief engineer. As a matter of course any immediate repairs that are needed are taken care of by instructions from myself and there is no question about their being taken care of immediately.

The Chairman:—The committee gave consideration that in making a recommendation for perhaps the rebuilding of a bridge, the inspector also should make a recommendation for repairs in case the rebuilding is not approved.

A. Ridgway:—I should say it would be entirely within the province of the inspector to make any recommendations he chooses. If the urgency of entire rebuilding would be apparent to the inspector, he should make that recommendation. If there is any question in his mind as to authority not being granted for that entire reconstruction it seems to me it would be perfectly proper for him to give an alternate recommendation.

G. W. Rear:—I would like to as briefly as I can, describe the method we follow. We are a railroad of considerable size, and have at the present date 715,000 lin. ft. of wooden trestles. A great deal of it is permanently temporary. We have 11 divisions, all up to a thousand miles in length, and we have the same organization on each, including a division engineer, a bridge and building supervisor and a division bridge inspector. The latter acts as a sort of assistant to the supervisor. He makes an inspection of every structure quarterly. In order to keep all the divisions on somewhat of an equal footing there are inspectors in the chief engineer's office who make a continuous annual inspection. They commence on the Texas border in the winter and work up into Washington during the summer and over into Utah and Nevada during the rest of the year. The division engineer, the bridge and building supervisor, and the division bridge inspector accompany the inspector from the chief engineer's office. They inspect everything they come to and make up their minds right there what is to be done. All parties are represented. The questions of the renewal of small trestles or trestles of larger magnitude are settled right there as to just what will be done and recommendations are made on the inspection notes. As far as the bridge across the large stream is concerned, that is generally under consideration and anticipated four or five years before it is actually done. Each one connected with the department knows that the time is rapidly approaching when a certain bridge will need renewal, and plans are being gotten out for it.

The inspection made by this party is not absolutely final, but it is subject, of course, to review. When the inspection party gets through with the division, they make up schedules showing all the work they found necessary that should be done the following year. They also make up an estimate of how much this work is going to cost, and find out how much of it is going to be charged to capital account and how much to operating. If the amount of work required is out of all proportion to that we could expect to get authority for, the inspection notes are gone over and individual jobs here and there are picked out where a probable expenditure of a smaller amount of money might tide us over until the next year. We had a great deal of that to do during the last two or three years of the war. With such an inspection representing all sides, anything that needs actual repairing before the next train goes over it, or within a few days, all the authority of the general office and the division is right there. They can telegraph for men and material, stop trains if necessary, crib up the structure or take any action that is necessary to make the road safe.

After this schedule of work is made up, a copy is sent to the superintendent of the division that has been inspected, saying to him that this work has been found necessary for the following year and to ask for proper authority for it. The superintendent and his staff get out the necessary applications for a general manager's order and send them in. When these applications for general manager's order come in they come first to a clerk in the assistant chief engineer's office, and he checks them over from the bridge inspection report. All applications for authority that are not on the inspection report, and according to that inspection's recommendations, are taken up specially, and if necessary, special inspections are made to find out whether conditions have changed in such a manner since the inspection that it is necessary to change the recommendations.

The principal advantage of this system is that each division on the railroad is in practically the same comparative condition. There is no one division that has been allowed to run down because the individual officers on that division for the time being either had allowed the money to be spent for something else or hadn't claimed their full and just proportion and used it. The general condition of the railroad at large is much better than where the inspection is made by the division and each division spends its own money without any supervision from the general office. (Reads Section 9, also Section 10.)

It looks to me as if we ought to leave out the words "if possible," and also "especially." I believe that the prescribed limitations for wooden bridges are as Mr. Ridgway brought out. I never took down an old wooden bridge but that I found that it was in much worse condition than we thought it was. Whenever you find a bridge that is of some age and you begin to find rotten spots in it, my advice will be not to sharpen the pencil up too sharp. I remember a bridge only eight years old which we found very badly decayed. I know positively that that bridge was absolutely sound in every way at the end of five years but at the end of three years more it was in such bad shape that we didn't get it repaired and rebuilt any too soon. The length of life between absolute soundness and absolute decay is sometimes extremely short.

The Chairman:—Would you care to say what you had in mind in connection with paragraph 10, Mr. Ridgway?

A. Ridgway:—I don't feel that it is possible in all cases to fix the prescribed limit of stress. What we had in mind there was to fix the limit of unit stress per square inch of the metal left. If you are familiar with the work of the Iron and Steel Structures committee of the American Railway Engineering Association, you will know that last year it brought in a change of its impact formula. I don't know that any man can tell what the total stress is going to be in any one of those bridge members. I don't think it is possible.

G. W. Rear:—I think it is perfectly feasible for any railroad to set a figure beyond which—according to its method of calculating, it will not go. We do it with wooden bridges, wooden stringers and all kinds of structures. While it is not possible, without testing the bridge to destruction, to find out the last pound that you can put on it, it is possible to establish limits.

Mr. Rear reads Sections 11 and 12.

The Chairman:—We were talking a minute ago about establishing a limitation in stress and said a good deal about figuring what a member is good for after it has deteriorated somewhat. I would like to say that that enters into steel structures quite often, as well as others. We may have a member that figures out to carry a certain load, but the manner in which that member is connected to the lower or upper chords may be very defective, and it may not be bringing out the full strength of that member. Likewise with a floor beam, the manner in which it is connected to the chord may be very weak. I want to say that we need a good deal of mature judgment in metal structures as well as in wooden structures.

R. H. Reid:—In connection with the various other members of the bridge those points should, of course, be considered in determining the unit stresses. The actual strength of a bridge member may not be the strength developed in the body of a member. It may depend upon the net section of the angle where it is connected to the other part of the bridge. If it is an angle eccentrically connected, that will decrease the unit stresses in the member. If it is an angle connected rightly, you have a lot more strength. The net section in determining unit stress is the net section, and all those features should be taken into account.

G. W. Rear:—The only point I want to establish is that it looks as though somebody connected with the railroad should set a limit beyond which you cannot go, and when it comes to the question of operating a new type of locomotives over the line there should be something more than mature judgment to enable one to determine whether he can let it go over or not. Pressure is brought to bear every day to operate heavier power over bridges than is considered good practice. I won't say that it is unsafe, and that the bridge will break down, or that any other terrible calamity might happen, but it is bad practice, and somebody, either the chief engineer or someone else, should set a limit beyond which one cannot go. This doesn't apply especially on the wooden trestle bridges, because as a rule they are not figured so closely, but when it comes to a large bridge, especially a truss bridge, positive limits should be prescribed. That is why I say that in conclusion No. 10, where it says that " Prescribed limits should, if possible, be established,"—I think it is possible. It may be that the prescribed limits may be much smaller than is actually necessary. As Mr. Ridgway said, the American Railway Engineering Association is changing its impact formula, but while we have an accepted formula let's use it, and stay within the limits that are given. I would like to have Mr. Schall continue on that. He is used to giving opinions as to whether certain loads can go over certain bridges.

F. E. Schall:—There is no question about regulating the different railroads to certain limits. On our system the chief engineer has charge of the structures. When a new locomotive is built a diagram of the locomotive is submitted to the chief engineer and he in turn submits it to the bridge engineer who passes on whether the engine may go over a certain line. If the engine is too heavy, in the judgment of the bridge engineer, he so reports to the chief engineer, who in turn so advises the operating department, and they either have to make the engine lighter or don't build it. That is an absolute rule that we are following very closely. Of course, we can't limit the railroad to the operation of loads for which the bridges are built. We can't fix a cast iron rule as to how much we are going to run over a certain bridge until we see it and calculate the stresses, and see how it stands up, how the various members are connected, how dense the traffic is and so forth. Bridges are not built to break down. Bridges are built to carry traffic and must be maintained. They must not be stressed to a point where they break down. You can set up a rule, and I dare say every well regulated railroad has such a rule. It is up to the chief engineer, with his bridge engineer, to adhere to the rules as to what power may be operated on that line. When you get up to the limit, then stop.

INSPECTION AND REPAIRS OF ROOFS

Report of Committee

A roof should receive as close if not more careful inspection than any other part of a building. The better and more permanent classes of roofs do not require as frequent inspection as those of the cheaper classes, but the inspection should be none the less rigid. It should include everything on the roof, such as skylights, ventilators, flashings, gutters, eaves troughs, downspouts, and adjoining masonry and brick work.

A supervisor must be careful to determine the economical limit of repairs in order to obtain the maximum life from a roof, and in so doing he must exercise due caution lest leaks occur in buildings where valuable goods are stored, resulting in serious damages. Some railroad buildings may be carried along indefinitely awaiting changes or new developments and in such cases a supervisor may be called upon to determine how best to carry the roofs without renewal with the least amount of expense until such time as the final disposition of the buildings may be determined.

A supervisor should always make a thorough inspection of the masonry and fire walls adjoining the roof, because the joints in the coping and brick work become so washed out within a few years, that water percolates down inside the wall, resulting in a report of a leak in the roof for which the roof proper is in no way responsible. The remedy is to remove the coping, repair and point up mortar joints in brick, lay in a damp-proofing course of prepared roofing, and replace the coping, pointing it up with a plastic bituminous cement. Sometimes a layer of the plastic cement is used instead of the prepared roofing. It is useless to attempt to waterproof the faces of the walls by moppings of various waterproofing compounds unless the walls are tight on top.

Flashings are a common source of leaks; those which are supposed to be permanently cemented to the brick work are rarely found thus after a few years of exposure to the elements. Large cut nails and flashing hooks should be used freely to hold the upper edges of flashings in place. The mortar used in pointing is often too soft; a rich cement mortar or bituminous cement should be employed in the repair work, applying it along the upper edge of the flashing.

In localities where melting ice during the day and frozen leaders during the night are a common experience, gutter heads are an active cause of leaks, which are rarely cured entirely. The flat metal portion of the gutter head should always be nailed down securely over the full thickness of the roofing and wall joinings; then the flat metal should be covered with solid moppings of felt and pitch, carried back at least 18 in. from the opening. If the metal is not closed in on both sides, the expanding ice in the downspout or leader will surely break the roofing away from it while it is cold and brittle. Straight runs of gutter which are improperly applied underneath roofing of various sorts frequently cause trouble of the same kind. The best remedy for leader troubles is the use of inside drains with heads like the Holt roof connection, clamped securely in place without the use of nails.

Roof coverings that depend on paint or other coatings to prolong their life are apt to become neglected, creating a liability of damage or premature loss. Especially is this so in the case of railroad buildings where frequent changes are made among officers and workmen.

Wooden shingle roofs usually have to be repaired with wooden or tin shingles. When such roofs become old they are a fire menace, especially when they are in close proximity to coal-burning locomotives. On account of the poor quality of wire nails many shingle roofs have to be renailed within a few years after being laid. There is no doubt but that if wooden shingles are dipped in a fire-resisting preparation before being laid, and are recoated at intervals of several years, they can be made immune from the ordinary fire risks from without. As a general rule the ordinary oil paint applied to shingles after being laid is a detriment.

Tin roofs require soldering or patching when in need of repairs. Temporary repairs may be made by the use of tested elastic bituminous compounds while leaks of a minor nature can be checked for a time by the application of a heavy coat of paint. Tin roofs should be painted with a good mineral paint about every four years.

There are many brands of composition roofings, commonly termed prepared roofings, which are laid in sheets or from rolls. Some of these will last from 10 to 15 years, while some of the cheaper grades depend on an occasional coating of some special preparation in paint form to prolong their life. Such roofs can be patched successfully, this being about the only manner in which repairs can be made. The seams and joints have to be watched and may require a little cement or renailing occasionally as this is where leaks are liable to appear first, especially if the laps were not properly secured when the roofing was applied originally. Roofs of this character must receive proper attention, for if a preparation of any kind is necessary to prolong their life it must be applied at the right time.

The last few years have seen the introduction of the asphalt shingles. No development in the field of roofing has come so rapidly as this. The result is a great variety of products of various degrees of merit from many different manufacturers. The asphalt shingle is simply prepared roofing of medium weight with mineral facing. When laid on suitable inclines to shed water it rarely leaks because there are always two and sometimes three thicknesses of roofing material. Shingles from uncertain sources are uncertain in color, but this is not a reason for replacing them. No method of restoring the color of discolored shingles has been developed. Sometimes shingles curl at the lower corners. It is difficult to replace them so the usual treatment in such cases is to nail the corners down with 1-in. fine wire nails.

There are all sorts of gravel roofs; many of them have been bought too cheaply. A three-ply roof made of light felt, put together with 60 lbs. of pitch and tar, and covered with possibly 100 lbs. of gravel, will need repairs inside of three years. A five-ply roof made of 70 lbs. of felt and 100 lbs. of pitch, properly graveled in will last seven years. The addition of 25 lbs. of pitch at the time the roof is built, will make it last from 10 to 15 years. A roof containing about 80 lbs. of felt and 150 to 250 lbs. of pitch, depending upon whether the roof deck is of wood or concrete (as recommended in the Barrett specification), will surely outlast its 20-year guarantee, and probably be good for 35 or 40 years.

Good gravel roofs are made of coal-tar pitch which has a melting point of about 145 deg. F. Roofs all over the country are subject to a temperature of from 130 deg. F. to 150 deg. F. every summer. Under such temperatures these coal-tar pitch roofs automatically heal any small checks that may have developed in the surface during the intense cold of the previous winter. One function of the gravel is to protect the pitch against the blazing heat of the sun. If any bare spots develop in a gravel roof, because of the use of inferior pitch, the substitution of tar for pitch, or failure to apply enough gravel in the first place, such spots should be covered with more pitch, and an ample amount of gravel embedded in it while hot. Many roof failures can thus be forestalled.

Standard gravel roofs or makeshift gravel roofs (hereinbefore described) can profitably be recoated at any time before the felt becomes exposed and begins to turn brown. The method is to sweep up all roof gravel with a stiff brush, pour on an ample amount of coal-tar pitch, and then resurface with clean gravel. It is safe to use the old gravel if it is screened, but a considerable amount of new material must be added to the old in order to secure a good job.

If the roof has been neglected until leaks develop, it is necessary to go over it carefully after it is swept up and in all places where cracks or serious rotting of the felt is found, such places should be covered with at least three thicknesses of felt and pitch, leaving margins in successive layers of the repair of at least four inches all around before the recoating is done. Most roof troubles develop angles where the roofs join walls, scuttles, skylights, etc. Two or three layers of solidly-mopped pitch and felt in such places never do any harm, and assist in making a good job.

About the only way to repair clay tile roofs is to replace the broken tile with new material of the same kind. When such roofs are constructed originally a number of the tile should be laid aside for repairs, especially if the material is of an odd design and not readily obtained in the market. The repair of tile roofs requires skilled labor.

Large pre-cast cement tile are coming into use, being applied to steel frames for inclined roofs. Few roof foundations are rigid. This permits some movement in the nature of torsion. For this reason leaks develop in the seams at right angles to the ridge and the use of flexible bituminous cements is becoming general for these seams. Such cement is readily applied with a pointing trowel or putty knife, but transverse fractures caused by freezing water are rarely cured by this treatment. Such tiles must be replaced with new ones.

A number of roofs have been laid in recent years with hard shingles made from a composition of asbestos, cement, etc., more nearly resembling slate in size and degree of hardness. In case of failure they must necessarily be replaced with new material of the same kind, if second-hand pieces are not available. These shingles have not been in use long enough to determine their lasting qualities.

Slate roofs are usually repaired by substituting new slate and this can be done readily because standard sizes are always available. A good slate roof having greater than half pitch will last many years without repairs. Slate is not adapted for roofs having less than one-half or one-third pitch, especially in northern climates as the water from driving storms and melting snows gets under the shingles and, if freezing occurs under such conditions, they become broken in great numbers. Where such conditions exist some roads cover the laps and seams with one or the other of the various elastic gums or bituminous cements containing asbestos fibre and weather-proofing oils which are coming into extensive use. This prevents further breakage and makes the roof tight. The cost of such repairs is $4 to $5 per 100 sq. ft., and should prolong the life of old slate roofs from 8 to 10 years. Elastic gums of this nature should be a permanent part of the equipment carried by every repair crew.

M. J. Flynn,
C. A. Lichty,
W. F. Meyers,
Committee.

DISCUSSION

(Inspection and Repairs of Roofs)

The Chairman:—You have all had more or less trouble with roofs and undoubtedly many of you have ideas about how roofs should be maintained.

J. S. Robinson:—In the inspection of roofs, especially of large shops, great care should be exercised to ascertain the cause of leaks. I was called on by one of our foremen to examine a bad leak in a slate roof. The building had been built some time before and we had never had any trouble with it before. I went through it with him and he showed me where an air lift was attached to the members of the truss, which were light. I examined the particular place where he said the leaks existed, at a time when no trucks were being lifted by air and again when they were lifting heavy freight trucks with the air lift. I found that this lifting pulled the trusses so that the roof leaked very badly.

As to shingles, we have both asbestos and asphalt roofs, and so far they are giving good success. We have more of the asphalt than we have of the asbestos.

The Secretary:—Mr. Myers furnished us with the information in the last part of the report which was drawn from his experience in using plastic cement. He had some slate roofs that were very poor and, failing to secure an appropriation to replace them within a reasonable time, he used some of this cement, troweling on a thin coating, and it left the roof in better shape than it was before. That cement has been on three or four years, and the roofs are still in very good condition. He thinks they will last five, six or seven years longer since they have received this treatment.

J. S. Robinson:—I have had a similar experience. I had a building for making carbide in, on which a prepared roof had been specified. It leaked and we covered it with an asbestos gum which has proven very satisfactory. It made a very neat roof and stopped the leaks so that we have had no further trouble with it.

P. J. O'Neill:—How was this applied to the roof?

The Secretary:—It was put on over the roof in a very thin layer so that it would get under the lower edge of the shingles and into every interstice. I don't know that it would be absolutely necessary to cover the flat surface of the slate, except to keep it in one continuous mass. It was put on about as thin as it could be put on, and probably it was easier to cover the entire surface. It made a very nice job, and has given very good satisfaction. I suppose that if this cement were troweled under the laps, in vertical and horizontal joints, it would answer the same purpose but it would take considerably more time to do that, and probably be more expensive.

W. M. Camp:—How is the cement applied?

The Secretary:—It is applied, I think, with a trowel.

J. S. Robinson:—We put it on with a trowel, about a quarter inch thick.

P. J. O'Neill:—We apply it with a trowel, and we have also applied it with a brush. It seems to me that a great deal of work is expended in so placing the cement that no back water can penetrate under the bottom of the slate. I can't conceive of a slate roof getting in such a condition that you would have to plaster the whole roof with cement.

J. H. Markley:—I placed a coating about ⅛-in. thick of a material called " Sel-mar-sel," over a roof about four years ago. It has stood the test of four winters, and is apparently as good as the day it was put on. We had similar trouble with gutters on the road, and we have used the same process. We had cases of galvanized iron gutters which had begun to leak and rust out at the joints. We plastered a little of that material over them with a brush, then laid on a piece of heavy canvas, and plastered again over the top of that. Some of these repairs have been on four or five years. I also use the same process on gravel roofs.

The Secretary:—Is that in the nature of a plastic compound?

J. H. Markley:—The same thing, but with a different name.

G. W. Andrews:—One thing many of us are prone to overlook is that, if we want a good roofing, we must expect to pay a price for it. Some of us are bound down by rules of purchasing departments that force us to accept as a substitute for what we know is a good thing, a material that is cheap, the cheapness being its only qualification. Take the prepared roofings as an instance. There are prepared roofings on the market that we can easily get ten years' service out of. I have known of instances where we got 17 years' service from prepared roofing without the application of paint, and it covered a large surface, too. I have known of other cases where prepared roofing was bought by the purchasing agent with the statement that " this was offered by a reputable manufacturer under a 10-year guarantee, without the application of paint," which we were forced to accept on account of the price, but at the end of 7 years the life of the roofing was gone absolutely, and that was as long as the company lasted that furnished it. Therefore, the guarantee was of no value. I say that in this particular line of roofing we should insist on high grade materials from a reputable manufacturer, whose guarantee is of some value. Unless we do that, we will be badly fooled. Most of us know that a metal roof is about the most uncertain roof that we can put on a railroad building. We have a great many of them, put on in previous years. Some of them have been on a good many years. They have been painted probably once a year, which is unusual for railroad buildings. But in late years we have been using on the metal roofs plastic cements of almost every type made in this country, and our experience with them as a whole has not been good. It stopped the leaks—stopped them absolutely—for 18 months to two years. Then when an examination was made with a view of applying more plastic cement, we found that it had eaten the metal, at least perforated it. We could pick it off with our fingers and crumble it like one would a crust of bread. I have come to the conclusion that for a permanent building with a pitch sufficient to hold the gravel or slag in place, the high grade, built-up coal tar or asphalt roof is the only one that is of any value. Of course we feel very often that slate is everlasting, but the nails with which we apply the slate are not everlasting. We have used the copper nails, wrought iron nails, steel nails, and none of them are everlasting. When the nail gives way the slate gradually falls out of place, and very often it breaks in falling. That means new slate to go in, and it means that you have to put the replacement slate in with a nail that is exposed. You can't get it under the slate above it; you have to put it close up to the edge. The result is that you have there a small leak which ultimately cuts out that nail. Of course, for roofs on heavy pitch the built-up roof is out of the question, because the slag that you put on the felt will not hold, but runs off; but for a light roof such as for a roundhouse or shop, where we can make it sufficiently light, I heartily recommend the built-up roofing. For temporary buildings I would never think of putting anything on but the prepared roofing, getting it on a 10-year guarantee, so it will be useful for any building that we want, for one year or for 10 years. We know, of course, that the most of our temporary buildings ultimately turn out to be permanent. With a 10-year guarantee we will get the full value of the roofing in the ready prepared type. With the built-up roofing on the small pitch, we will get a roofing that will last indefinitely. I can recall a roofing that I put on a building in Philadelphia in the summer of 1886, and 26 years afterwards when we tore that building down the original roofing was still on and still intact. It was a built-up roofing. All of our roundhouse buildings are now covered with that type of roofing. The resultant effects have shown that we were justified in using that type. We have, of course, a large number of slate and tile roofs, and as far as the material in itself is concerned, no objections can be raised, except as I have already stated, that we must get a nail that will hold that roofing in place before we can call it one of exceptionally long life.

C. J. Scribner:—We have used plastic cement for repairs with very good results. One of our large depots needed repairs to the gutters three years ago, and this cement was used, with canvas or muslin to hold it together. While we have made no inspection of this roof, we have heard no complaint about it from the division people, and that is a pretty good indication that the roof is all right today. That expedient saved us several hundred dollars in that particular case. As I understand it, this roof, if used as an entire roofing, is very expensive, but it is claimed for it that it is of very long life. One of the principal features claimed for this cement is that it will adhere to almost any surface. You can apply it to a tin roof, a wooden roof or a slate roof; also it is claimed that it will stick to that material even though the surface may be wet, so that the proverbial old man might go out and repair his roof even in a storm.

Another feature of this material is that it is always plastic. This feature led us to apply it to a water tank that leaked. There was a layer of concrete in this water tank and as the staves rotted and gave way from the concrete, the leak developed beside the concrete. We drained the water from this tank, cleaned out the mud, applied a coating of this plastic cement and then a coating of muslin, and then more cement, with a result that about 70 per cent of the leakage of that tank was stopped, and the life of the tank was prolonged and its renewal delayed for about two years.

G. W. Rear:—Mr. Andrews is correct about the roofing business. Everyone knows that the purchasing department forces things on us that are really not of the best. It will continue to force them on us and we must make the best of it. Nevertheless, those that have charge of the specifying of roofs can at least specify the right thing, even if they don't always get it. I think Mr. Andrews is right in that a roof put up after a certain standard specification, will give service far beyond any ordinary guarantee. Incidentally, I don't think a guarantee is worth very much, because if a roof is guaranteed for 10 years, and it goes 9, either the people that you bought it from are not in business, or they can find some reason why the roof gave out.

Regarding the slate roof, slate, of course, is permanent, but it has many enemies outside of the nails. I remember one rather beautiful station which we were somewhat proud of, with a slate roof on it. We received a message one time that the roof was in a very bad condition. The building had then been up for about 15 years. It was a wonder to everybody that the roof should have gotten in such a terrible condition so suddenly. I happened to be in that neighborhood, and I made a little investigation of my own. I found that the telegraph men had strung about 15 wires lengthwise of the building overhead, and in taking up the slack they let the wires drag over the roof; each wire took off a lot of the slate. We also find that slate roofs are ruined by people walking around on them. Even if we could get a nail that would last forever, it is doubtful if a slate roof could be maintained forever.

Regarding this plastic cement; some people are putting it on with a kind of a grease gun. Somebody may know something about that particular method of application.

G. W. Andrews:—I am willing to agree with Mr. Scribner that cement applied as he states may be a good thing. I don't doubt but that it is. My remarks covered the application of the cement on raw metal, and not on a muslin or canvas under-coating. If we put a coating of this cement on the raw metal and cover that with a coating of canvas or muslin, we protect it to a certain extent from the weather. Then we put a coating of cement on the muslin or canvas, which protects it. No doubt in a case of that kind we would get much better results, but the statement that I made, and which I still make, was that the cement had a deleterious effect on the raw metal, and that while it stopped the leaks for a short period, the ultimate result was not good.

The Secretary:—That might not be the case with all brands of cement. Some of these compounds do not have a bad effect on metal roofs.

E. K. Barrett:—I would like to cite a case from my experience. I have many galvanized iron roofs and up to about 10 years ago it was very hard to get anything to stick to them. About ten years ago I had a warehouse roof of galvanized iron that was pretty full of holes. At that time we were hard up for money, and I got a contractor to agree to put on a roofing cement, and guarantee to save me that roof for three years. He put on the preparation and it carried the roof for seven years, at the end of which time it commenced to leak a little again. I went over it and decided it was in good enough shape to treat again, so I went over that roof with another coat of this material, and it is still giving good results today. I contracted that coating for $1.65 a square, as I remember it, 10 years ago. You buy it by the barrel and apply it with a brush.

C. J. Scribner:—I might say that the use of canvas or muslin is not intended, as I understand it, to be in any way a protection, but this plastic cement always remains plastic, and if the opening is very large, the cement will draw through it. The canvas or muslin is to prevent that—to hold the cement in place.

A. Ridgway:—I should like to ask the committee if it gave any attention to the repair of concrete roofs?

The Secretary:—Evidently not, from the report.

E. K. Barrett:—I had to put a concrete roof on a vault building about four years ago, and about three months after I put it on the trouble started. I tried several things on it without success, until I bought some asphalt and went over the whole roof with three heavy coats. Since which time I have had no trouble.

F. C. Baluss:—I have had experience with concrete roofs on a slope of about 1 in. in 12. When the roof was new I applied a coating of cement and after five years we have had no trouble. I have renewed the protection with the same cement again as it has been very satisfactory, and it is very cheap.

C. Ettinger:—Mr. Andrews is right in stating that he had trouble with plastic cement where the compound had eaten through iron or tin. But I believe I can give a reason for it. We should ascertain whether these plastic cements and plastic compounds contain coal tar, especially in the crude form. If they do they are bound to attack metal. You will find the plastic cement compounds of good quality can be bought by the purchasing department, but they will not pay the higher price. Some of the compounds with sulphuric oxide as a base, with the addition of a pure gum, will stay on copper, to my personal knowledge, for five years, on a longitudinal joint. We know that copper contracts and expands just the same as iron and steel does. I put some cement for a trial, on a joint on a copper cornice, and it remained there for five years before it commenced to tear. It is a question of the right compound more than anything else. We have tried the muslin protection on our road. We apply a coating of this cement in the consistency of heavy cream, then we lay a layer of light muslin, and on top of that we mop some more of this paint. We have carried roofs over in this way for five years, but they were gone after five years. You could tear the muslin just like rotten paper. But it is a good thing on buildings that you must carry over and which it is intended, perhaps, to replace in the near future. You can do that at present prices at about $6 a square. When we started out 6 or 7 years ago I did it as low as $2.50 a square.

L. Spalding:—I have had a good deal of experience with leaks in concrete roofs. We have several concrete buildings among our shops, one of which is a store house with a plain concrete roof over it. This building was built six years ago, and, after the first year, we had trouble with leaks, due to contraction and expansion. Pitch was applied at that time, but did not prove satisfactory. Four years ago we removed the pitch and used plastic cement in the cracks, since which time we have had no trouble. We also had a roundhouse with a concrete roof covered with gunite, put on with a cement gun, that has caused a good deal of trouble in the past few years, due to the very fine cracks developing in the gunite, allowing the water to go through. I happened to get up on that roof on a hot day last summer. I went over it with a magnifying glass one day to see if I could find any cracks. I could not find them but by turning the hose on a small portion of the roof with the hot sun on it, and allowing the water to evaporate, the fine cracks showed up very quickly as the water in the cracks did not evaporate as quickly as on the flat surface of the roof.

METHODS AND EQUIPMENT USED IN RENEWING TIMBER BRIDGES IN WHOLE AND IN PART

Committee Report

Railroad timber bridges are as old as railroading. The art of building them has been well developed for many years and, as their construction is quite simple, new features are not frequently brought out. As timber has become harder to obtain, traffic heavier, and the country drained, more permanent types of bridges have been constructed, or the openings filled and abandoned. On many roads an untreated timber bridge is now built only as an emergency structure. Improvements in methods in recent years have been confined largely to tools. These are mentioned elsewhere. As a consequence of these conditions this report is largely a résumé of present practice.

Repairing Timber Bridges

In general, gangs for timber bridge work consist of a foreman, an assistant foreman, and six or eight men as follows: two first class carpenters, two assistant carpenters and two to four laborers. Variations from the above are made as the work demands or in accordance with the kind of men available.

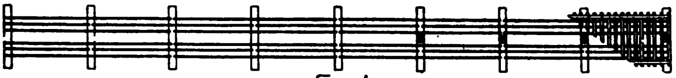


Fig. 1

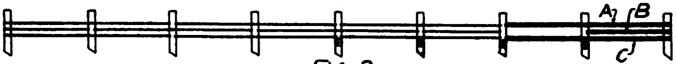


Fig. 2

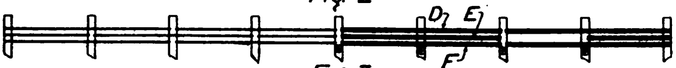


Fig. 3

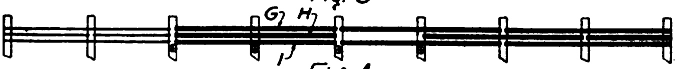


Fig. 4

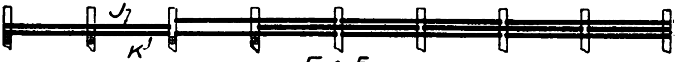


Fig. 5

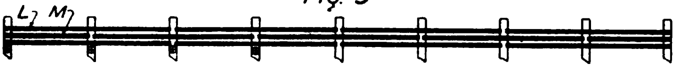
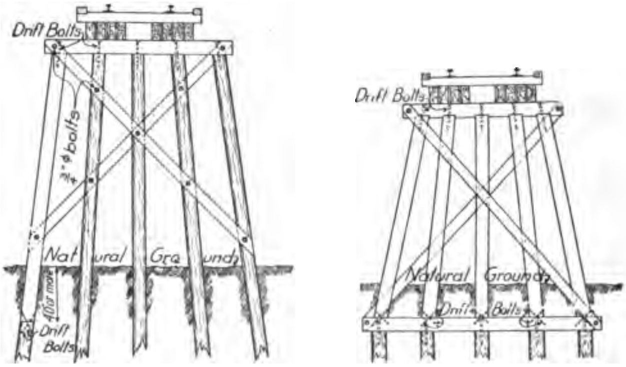


Fig. 6 Note;- • Indicates jacks.

The distribution of material depends on the quantity to be handled and traffic conditions. Where material is ordered from the mill, cars may be consigned to the station nearest the bridge site for unloading or redistribution by one of the methods mentioned below. When shipped from the storehouse, the use of company service cars may be found convenient. These can be held under load and shipped from point to point as the work progresses. For unloading use may be made of a special work train or, where the quantity of material does not justify this expense, recourse may be had to a local freight train. When two or more cars are to be unloaded it may sometimes be found economical to distribute the unloading by local freight train over several days. Small quantities are handled by motor trailer or push car.

There does not seem to be uniformity of practice in the use of second hand material in any given part of the bridge. It would appear to be the best policy to use second hand material only for blocking and helpers on important lines, but it might be used somewhat more generally on light traffic lines in bridges, the life of which will not be greater than the life of the material.

Where one-third or less of the piles in a bent are in bad shape satisfactory repairs can usually be made by cutting off in solid material at or below the ground line, and setting in a post on this foundation. Such a post will have a better appearance if it is of the same shape as adjacent piles. It should be spliced to the foundation pile with four three-inch scabs bolted through, drifted through the cap at the top and well bolted to the bracing. It should have an identifying mark as a helper. Posts are sometimes put in on blocking between piles. A weak pile may thus be relieved of some of its load and at the same time the benefit of its stiffness be retained. A repair of this kind is an obstruction, if placed in a stream, and is unsightly in any situation. In cases of settlement or where piles are decayed far below the ground line, it may be necessary to drive a new pile along side the old one and spring it under the cap. When entire bents are to be removed, in most cases, the pile may be cut off at sound timber below the ground line and a frame bent erected on this solid foundation. The bent should be framed without a cap, set up and made ready to slip in as soon as the piles are cut off. When conditions require it an entire new bent may be driven along side the old bent, the new piles sawed off, the old piles cut out and the new bent pulled into place. Some roads restrict the height at which frame bents shall be used in this manner to ten feet.



Note:

Thoroughly tamp the ground around all new work.

In replacing with posts, dig down until sound timber is found and in no case less than 4'0" below the surface of the ground, except where water prevents.

In replacing with frame bents, dig down until sound timber is found.

In renewing caps it is first necessary to pull the stringer drift bolts to clear the cap. Then jack up the deck one or two inches, (jacks may be supported on the ground or on sash timbers bolted to the piles for the purpose), raise the old cap to give room to cut off the drift bolts with a hack saw. When this is done, roll off the cap. The new cap having previously been framed and a hand line attached about its center, let it down over the side of the deck and swing it into place. Drift it to the piles, lower the deck and redrive the stringer drift bolts. When a scaffold is necessary for this work it may be hung from the ties with staging hooks carried regularly in the outfit for this purpose. An old cap may also be removed readily by cutting it into three or four pieces and splitting it out. This gives easy access to the drift bolts in the tops of the piles.

The renewal of an outside stringer is quite simple as it is only necessary to withdraw the bolts, jack up the rail and ties about two inches, turn down the stringer to be removed, shove it out on the caps, drop the new stringer previously framed on to the caps and raise it up and bolt it. To renew the middle stringer in a chord the method is similar but with broken joints it is necessary to remove the bolts extending over four panels. After raising the track, the two outside stringers are laid down, the weak center stringer removed, the new one placed and the balance of the chord reassembled. When it is necessary to renew an inside stringer it may be done in single panel lengths from the inside as described above, the new stringer being handled with lines through the deck. In renewing an inside stringer extending over two panels, it is necessary to take up the guard rail and shift the ties, either along the track or to one side. It is then possible to drop the new stringer vertically into place. This method may also be followed with center stringers. Some prefer to raise the track a little more than the width of the stringer, roll the old stringer over to its side and raise it and work it over the chord and on to the caps. The new stringer is placed by reversing this operation.

A method of strengthening the chord involving much less labor consists in adding an additional stringer on either side of the existing chord. It is not, however, good practice to leave partly decayed timber in a bridge because of the fire risk.

In renewing isolated ties, remove the adjacent deck bolts and pick up the track about six inches. Place a 4 in. by 4 in. stick about 10 ft. long across the stringers on each side of the tie. These may be held in place by wedging under the rail or other means and should project on the side toward which the tie is to be moved. Rollers are slipped under the tie and it is rolled out until it clears the rail, when it can be lifted up on to the track and disposed of. Where a number of ties are to be renewed, put in all the new ties in one place and spot in the good second hand ties where needed. In such cases it is usually necessary to take up the guard timbers where the new ties are put in. Another method is to raise one rail higher than the other, slip the ties out to clear the low rail and then back and over the low rail.

It is usual to lay guard timbers in position and mark the location of the ties. The daps are then cut in them, either on the bridge or the bank and the timber placed in final position. It is the practice of one road reporting to this committee, where more than 50 ft. of guard timber is to be replaced, to measure the tie spacing on the bridge and dap the timbers in the shop.

Renewing Timber Bridges

The year's program for timber bridge work having been determined, it is usual to do all the driving in advance and let the pile driver crew return later to place the timber, or have this work handled by other crews. A minimum of pile driver and work train service is thus secured. After locating the bents to the best advantage relative to the waterway and clear of existing bents, and marking their location on the rail, the guard timbers are taken up, the ties are shifted to clear the new bents and driving is started. It is usual to work backward on a bridge. The work will proceed more rapidly if piles are distributed on the ground in advance. After driving the piles, the ties are respaced as well as is possible and guard timbers are relaid, cutting out the spacers where necessary.

When the bridge crew arrives at a bridge where the piles have been driven as above, the first step is to straighten and line up the piles. This may be done with jacks and steamboat ratchets and the piles should be held in position. If badly out of line this work should be done with the pile driver before it is moved from the job. After marking the grade, usually obtainable from the track, and attaching a guide board the piles are cut off. The stringers and deck are then raised about two inches on the old caps to permit the placing of new caps. The cap is brought in, swung off the deck on to the top of the piles and drifted in place. Sway bracing is next put on and bolted up. With high bents, say over 20 ft., some longitudinal bracing should be put on as the stringers are placed.

As soon as two or more caps are in place measurements for the length of the stringers are obtained and the framing of stringers can be started. This should be done on a level stretch of ground as near the bridge as possible and consists in cutting to length, sizing to depth over the caps, and boring for drift bolts where they are used. Holes may also be bored through one line of stringers in each chord for packing bolts.

Methods of assembling stringers into chords are varied. In most cases one chord is changed out completely before the other one is disturbed. Information in regard to the methods described below was furnished by E. M. Grime, supervisor of bridges and buildings of the Northern Pacific at Dilworth, Minnesota, and applies to chords with three stringers. All bolts are removed from the old chords and the deck is raised about one inch. One of the old chords is then shifted a few inches toward the center of the bridge and the stringers of one new chord assembled in order on the ends of the caps in the space so provided. Stringers of both old and new chords are then shifted in toward the farther old chord, permitting the second new chord to be assembled in like manner on the caps. Then with all four chords on the caps, they are gradually crowded over in the same direction, one stringer at a time, until the old stringers can be lifted off the caps at the farther side and the new stringers reach their correct position in the bridge where they are bolted together and fastened to the caps. While this method is somewhat slow it commends itself because the work can be carried on with a crew of six men and with no delay to traffic other than a five or ten mile slow order over the bridge.

In the second method described by Mr. Grime, the bolts are removed from one chord and the center stringers of this chord are cut in two so that they may be removed two panel lengths at a time. Beginning at the end, the bridge is raised on one side over four panels on jacks placed on the caps. Two panels of the old chord are then taken out and two new panels, omitting the center stringer in the second panel, are put in. Three full length stringers are next placed in panels three and four and the center one slipped back to panel two and three. Jacks are then moved forward and this method is followed across the bridge until the end two panels are reached, when the inside and center stringers are placed, the latter slipped back one panel and the additional center and outside stringer placed. Bolting and bracing can follow along as fast as the stringers are in position. Following this method the work can be well handled by a crew consisting of a foreman and six men. It is necessary for the foreman to keep in close touch with the dispatcher and for this purpose a portable telephone is a great convenience. It should also be noted that one-third of the old stringers are cut into two pieces.

The method of renewing individual ties has been described. In renewing a bridge, when the old ties are in bad shape about one half the new ties are put in between the old ones before placing the stringers. This gives a more substantial deck to work from. The remainder of the new ties are put on after the stringers are changed. Ordinarily ties are put in between the old ties or in groups as traffic permits, after the new stringers are in. Some roads defer this work until all the heavy timber released is picked up to avoid scarring up the new deck. With the placing of guard rails the bridge is completed.

Released material of no value is ordinarily burned at the site, or disposed of for firewood, but good material should be loaded with a derrick car and shipped to division store yards for further use. In the last few years a number of railroads have been cutting released bridge timbers into dimension materials for use in building work. Such material is seasoned and is frequently of better quality than new timber.

Every bridge gang should have a sufficient supply of the ordinary tools of good quality. Where special tools have been tried out and proven advantageous, gangs should be supplied with them. There can be no argument about the desirability of labor saving devices at the present time, not only as a means for reducing the amount of labor but for keeping the men employed better satisfied. Among such agencies first place should be given to the motor car and its trailer for handling small amounts of material. Ball bearing jacks, patent bushed blocks and thin-backed saws are some of the devices that lighten labor and shorten the time for doing the work. A hand winch or crab mounted on an "A" frame or gin pole or a push car, is almost a necessity in every outfit. Devices of this kind are described in the Proceedings for 1918.

Maro Johnson.
E. K. Barrett.
E. E. Clothier.
F. N. Graham.
A. J. James.
J. P. Wood.

DISCUSSION

(Renewing Timber Bridges)

The President:—Gentlemen, this is a good report on a subject that everyone of us is vitally interested in. It seems to me that this ought to call for active discussion.

E. K. Barrett:—The report mentions the jacking up of stringers by bolting on side braces. I get away from that by using a 2-in.x2-in. extension clamp which leaves it 12 in. in the clear, and the horns drop down and catch under the outside stringer. The saddle catches over the foot lift of the jack, so I don't have to bolt on any sash braces. I simply roll the jack into place and it will pick the stringers up without bolting on side braces.

G. W. Rear:—My understanding of this idea in trying to get the cap out was to jack up the weight so as to get it off the cap. The only objection I have is to the driving of piles under a trestle without the stringers having been shifted so that the piles are driven in their proper place. I don't believe that a good job can be done by trying to drive the piles unless the stringers have been shifted so as to get the pile started where it is intended to be, and driving it where it is intended to stay—either with a 3-ply or a 4-ply chord. We have never yet been able to find a way of doing a good job without shifting the stringers, especially on the lower trestles. It may be that when the trestle is of considerable height that the piles can be spotted in without springing them too much out of the way. We find in our practice that the best way is to go to the bridge with a pile driver and finish up the job before you leave it. The first thing to do is to shift the stringers and make a place for the piles to go. When you do that, and the trestle is finished, it will stay in line. It may be that the experience of some people may prove that they can be sprung in place satisfactorily, but we hardly believe that it is the right thing to do.

E. K. Barrett:—I notice that the report says to "Lay your guard rail on," etc. Our guard rails are all standard, and if one is removed it will fit somewhere else. In putting in ties it is our custom to take out the full number that we have new ones to replace and put them all in together, and then spot in the old ones at intervals where we can use them.

J. J. Taylor:—Referring to the remarks about strengthening bents by driving additional piling, I have had a good deal of experience with that, and do a great deal of it. I agree with the thought that to drive the pile on the side and jack it under gives poor results. Our plan is to jack up the chord, shift the cap endwise, and drive the pile exactly where it belongs, saw it off, shift the cap back the other way and drive the pile on the other side. In that way you get the pile standing normally, where it is trained to go, and get much better satisfaction. It can be done with a pile driver crew very readily while they are there.

G. W. Rear:—With regard to the renewing of the ties, I think that circumstances govern cases. We often find that joint ties under the rails are gone long before the others, especially with continuous joints. We renew them many times when no other ties on the bridge or trestle are renewed. We find on long trestles a tie here and there that should come out, and we renew those particular ties. I don't think that it can be said that it is good practice in all cases to renew all the ties together in one place and stick the second-hand ties in here and there. I think there is room for the display of a considerable amount of judgment there.

J. P. Wood:—Ordinarily such ties will go over until several can be taken out within a short distance. It has been our practice not to renew any ties unless they are damaged by fire or are extremely bad, until we can renew 15, 20 or 40 at one place, as this saves a considerable amount of time and labor. It has been demonstrated by my experience that if you have only one or two bad ties in a place, they will ordinarily carry. You may have to dap out and insert some ties of hardwood timber. They will carry you over until you get time to put in others.

A Member:—I don't agree with Mr. Wood, for the reason that if you are going to let ties go until you can renew 25 or 30, you are liable to let it go until there are 40 or 50. I believe that the ties should be looked over every year and those that are to be renewed or repaired should be taken out. I don't agree that it pays to take a number of ties out in one place and then jack up the track and scatter them through some place else. I believe that a tie that will go over a year ought to be left in the place where it is, and the next tie to it, if bad should be replaced.

G. W. Rear:—We use a standard tie, dressed in the mill to 7¾-in. by 7¾-in. Every tie we put in is of that same size and no sizing is done after that. A ship spike is driven through the guard timber into the tie. When we go to renew the tie we pull this spike out, nip the rail up a little and slip in a new tie.

E. K. Barrett:—There are many different ways of putting on a guard rail. With us the guard rail is bolted to every fifth tie, and the other four ties are not fastened to it in any way. I prefer to put the ties in in a bunch to avoid putting a full size tie beside one that is rail cut. When I have 30 or 40 ties to put in a bridge, I place them all together, for the simple reason that it leaves the rail supported on ties of the same height; not with two or three full size ties spotted in with two or three ties that are rail cut.

P. N. Watson:—We frame such ties as are necessary for the structure to the right size in the shop and ship the ties to the bridge. We then lift the rail with a hoisting engine, block it and slip in such ties as are necessary, then drop it down and go to the next place. We don't bunch our ties, because of the fact that many of the old ties that come out may last longer than the new ties we put in. We find that plan much more satisfactory than to put in all new ties and place the old ties elsewhere.

A. S. Markley:—I fully agree with what Mr. Barrett says, that new ties should be put in all together, because the old ties are rail worn. The use of old ties in the track is a serious proposition in case you have derailment. Recently we had a 250 or 300-ft. viaduct on which loaded cars carrying 140,000 lbs. derailed, damaging the ties so that it was necessary to remove them. We took those ties out, cut them off to 9 ft. and used them again.

G. W. Rear:—Unfortunately I can't gain an idea from this argument as to what is to be done with those bad ties under the joints. Naturally no ties will be renewed unless they need renewal. If you have two or three ties here and there for a distance of ½ mile across a trestle, and you count them up and there are 100, and you then say that you will put in 100 new ones here, and take the old ones and put them in some other place; I don't see that anything is gained. The chances are that you could find enough second hand ties around the road to do this work without taking them from that particular trestle. In extremely bad places, where the ties have got to come out, they could be replaced with second hand ties or new ones. We have no rail cut ties because we use substantial tie plates on each tie and as we have about three times as many ties on a trestle as on the bank, the ties on the trestle don't cut. Where you have no second hand ties in good condition, new ties ought to be placed where they are needed. Modern methods of putting them in make it a comparatively simple job, and I venture to say that six men will put in 75 per day.

E. K. Barrett:—What about the fellow that has no tie plates? I can show you plenty of ties on my bridges that are cut three-quarters of an inch deep. If we take out one hundred ties and put in one hundred new ones, we then scrap the ties that are no good and use the others under the joints you are talking about.

A. S. Markley:—I can't see the advantage of transferring the old material to another bridge. You can cut down the old ties under the continuous joints.

J. L. Pickles:—We get around the rail cutting by taking the guard rail off, putting the new ties in promiscuously, and turning the old ties over.

A. S. Markley:—Where you put in new ties continuously you know that it is not necessary to disturb that part of the bridge again until those ties are worn out, while if you are spotting ties continuously you have to keep disturbing it.

F. C. Baluss:—There is another point to be considered—the cost of labor. If you take out enough poor ties and bunch those together and replace them with new, all in one place, you are going to spend more money doing that than it would take to buy tie plates. We find, and I think you all do, that labor is as hard to get as material, if not more so. The matter of cost must be considered in these matters.

The Chairman:—There ought to be some discussion on the method of renewing stringers.

M. M. Carmody:—I don't quite agree with the committee report in the suggestion that the third chord be cut in two in order to remove it. I think this is a mistaken idea, and a very expensive one. I have had 22 years' experience in that line. We used to cut the third chord, but I find the only remedy in renewing the chord is to shift it back when you get it properly jacked up and free. You have four pinch bars lying on the bridge handy, and an organized force will shift that chord back in a few minutes. Consequently, you have saved 20 to 30 min. in sawing that chord in two. I have an extra chord to drop in to take the weight where one has come out on the outside. I notice that some of those here have said that the ties are cut down three-quarters of an inch. As a rule we clear the deck on the main line and carry the second hand, or best ties, back to the side lines. I don't think it is good policy to patch in ties, when you can take care of your best second hand ties anywhere.

A Member:—It has occurred to me from about 27 years' experience that when we have at least twice as many ties on a bridge as are necessary to carry the load it can be allowed to go, provided the ties are not all in one place, until 50 per cent of them are ready to be renewed. Then all the ties can be taken out and the deck renewed entirely, working the second hand bridge timbers into building lumber, where there is less danger of accident than there is on the bridge. Where too much patching is required with timber bridges it is cheaper to renew the bridge and work the second hand stringers, ties, caps, etc., into building lumber of various sizes, thus keeping the bridge in good surface, line, and safety. I have had the experience where a bridge deck had been patched so much that it had gotten out of surface and line to such an extent that it was necessary to take all the ties off and re-deck the bridge to get it in surface. I believe there are other members here who will say that the better method of disposing of the second hand bridge timbers is for building material.

G. W. Rear:—We will all agree with the last speaker that 50 per cent of the ties could be permitted to get bad before the deck is renewed, providing the 50 per cent were distributed alternately, one good and one bad one, but suppose that the 50 per cent are all in one spot.

Returning to the renewal of stringers—no two people will agree as to how to change them out. If I was to tell a foreman how he should renew the stringers on the job he was going to start tomorrow, I couldn't tell him how to go at it. He might not have a train from seven o'clock in the morning until six at night or he might have a train every five minutes. He might have only 2 men or he might have 25 men. Those two conditions would require radically different methods. How are you going to establish arbitrary rules with conditions like that?

Mr. Estes:—In changing out caps I have used four jacks, two on each side of the cap to be changed. Our bridges are bolted together. You can lift the cap up and take a chisel bar and cut the bolts off. If you are high in the air you would have to throw in a temporary scaffolding to handle the bolts. You won't have to use any blocks in changing your pile.

Mr. Johnson:—I am interested in the reclamation of relieved lumber as building material. I understand that they do this on the C. & E. I. Perhaps Mr. Markley can tell us something about that.

Mr. Markley:—I don't think there is anything in it. (Laughter.) With second class material, and ties in particular—way out in the country—you may have to stop a train to load a few ties on a car. You send the car in to headquarters 100 miles away and get it unloaded. In doing all that you have run up more of a bill than the timber is worth. When we take up the ties we use them for bulkheads and similar purposes, but we never work them over.

INTERNAL COMBUSTION VS. STEAM ENGINES FOR PUMPING WATER

By C. A. Lichty

In the early days of railroads the steam pump had no competitor. It was purely and simply the question as to the type of steam pump and outfit that was best adapted to suit the conditions. Steam was the "old reliable" for so many years when it was the only power considered practical that it has in many cases been difficult to supplant it with the newer type of plant, especially where coal and labor were cheap and where the quality of water was good for steaming purposes, and more especially as long as the plant in use was capable of rendering the service, regardless of economies that might be effected by the installation of a more modern plant and apparatus.

Some authorities maintain that the larger and more important pumping stations can be operated most successfully by steam, while others are substituting internal combustion engines, even in the immediate vicinity of the coal fields. Many, especially on the northern roads, maintain steam plants, making use of the exhaust steam by running it into the water to keep it from freezing in the tank; besides, when the pump is not in service live steam can be used for the same purpose, as well as to thaw ice from spouts, valves, etc. In most of the states steam plants are subject to a rigid inspection. For instance, in the state of Illinois, boilers must be inspected and tested four times per year, and the plants operated only by licensed enginemen.

One of the principal reasons for getting away from the steam pumping plant, is on account of frequent renewals of boiler sheets and flues. In some cases boilers have to be changed out in from six months to a year, depending on the nature of the water, necessitating the boilers to go to the shop for repairs. This entails considerable annoyance and expense.

Tests for efficiency as far back as 1882 showed that the gasoline unit was an active competitor with the steam plant for small installations, and about 10 years later it was generally conceded that it had gained the supremacy, but just about that time the rapid development of the multi-cylinder, small type of engine used so extensively for propelling automobiles, trucks, motorcycles, airplanes, etc., created such a demand for gasoline as to give the larger sizes of internal combustion engines a temporary setback until it could be arranged to operate them successfully with kerosene and the cheaper grades of fuel oil, since which time they have again made considerable progress.

The cost of installation of the two types of plants under consideration, of like proportions, may differ but little except for plants ranging from 1 to 10 hp., where the oil equipment would be much less. In fact, for plants of this size steam can scarcely be considered a competitor. In some installations of from 20 to 50 hp. the oil engine may be more expensive than the steam engine and boiler. When the additional space for the housing of the latter and its fuel is taken into consideration, it is doubtful if, in many instances, the steam plant has any advantage in cost.

There is little room for doubt but that the oil engine is much more economical in the matter of attendance. The steam boiler requires nearly an hour to get up steam and almost constant attention thereafter for firing and all of the other necessary requirements, while the oil engine can be started in an instant, and when properly installed and adjusted the attention required is only nominal. It is well known that many of the smaller pumping stations are successfully operated by agents, baggagemen, sectionmen, etc., when conveniently located, in connection with their other duties, requiring but a small share of their time.

A steam plant necessitates about six times the space for transportation and storage of coal that oil does; besides the latter may be conveniently stored underground, where it is entirely out of the way. For reasons just stated the labor required for the handling of coal and ashes is several times that for oil. Some roads require coal to be delivered to pumping plants in considerable quantities during certain seasons of the year in order to render cars and labor available for other purposes when they are most needed. The result is that the coal is most always stored outside, where it deteriorates to some extent and is liable to be stolen or may catch fire from spontaneous combustion. A leading authority from one of the prominent railroads estimates that the loss of fuel from all sources in connection with a steam plant sometimes runs as high as 40 per cent, while in the case of oil it is very slight.

The Diesel type of oil engine has reached such a stage of economical operation, together with the small amount of space required for engine and fuel as to come into general use for boats and ships and all kinds of stationary plants from 6 to 500 hp. They operate successfully with all of the cheaper grades of oils except those having a decided asphaltic base, and the manufacturers now claim that they will soon be able to operate on such oils as well.

The thermo-dynamic efficiency of the semi-Diesel and true Diesel engines ranges roughly from 20 to 35 per cent. The economy in fuel consumption therefore is large when compared with the consumption for ordinary steam engines when it is recalled that the efficiency of the small 4-valve Corliss engine is about 6 per cent; the Corliss compound 9 per cent, and the triple-expansion engine rarely reaches 18 per cent. It is a well-known fact that the simpler types of steam pumps are the most wasteful.

The cost of the different fuels varies, of course, in the different localities, but there is scarcely any place in this country where oil can not enter into competition with coal for the purpose outlined in this subject, while, on the other hand, in many localities the steam plant can not enter into competition. A concrete instance of the relative merits of the two types is cited in the case of a steam plant in a small town which was recently replaced with a modern type of oil engine for operating a small electric lighting plant, where it is stated that the former cost of operation of 20 cents per kw. has been reduced to 4 cents by the new installation. It is not known whether the total difference was due to the change, but no doubt much of it was. In this particular case both coal and oil were produced within 100 miles of the plant. One of our prominent railroads recently installed an oil engine at a pumping station where steam had been in use many years, and a total saving of fuel and labor has effected a saving of from 30 to 40 per cent. Both types of plants are in such general use and their characteristics so well known that when all of the conditions are taken into consideration it should not be difficult to determine which should be selected for any particular locality.

DISCUSSION

(Internal Combustion versus Steam Engines for Pumping Water)

E. A. Demars:—I consider that a gasoline or an oil burning engine, when installed off the right of way, on a river or a small stream, is more economical than a steam plant, but I consider that steam is more economical than fuel oil for pumping water on the right of way.

J. Dupree:—It states in the report that in the State of Illinois "boilers must be inspected and tested four times per year." I never found that to be the case, but it is in Indiana, which State has the most rigid laws relating to boilers on railroads of any State in the Union. I am in accord with the last speaker in regard to the relative economy of gasoline and steam engines. I think that a gasoline or an oil engine is the thing to have away from the railroad right of way. We have one pump house a mile from the station and half a mile from the track, at which we use kerosene. At this point we have a kerosene carburetor. We have several others and they give excellent satisfaction. But for a large station, such as at a large terminal, I prefer a steam plant at all times.

J. P. Wood:—I would like to ask the gentleman for his reasons why he thinks steam more economical.

E. A. Demars:—On our road I have found it to be more economical, because it is difficult to get men to operate gasoline engines and keep up the repairs on them, while almost anybody, with slight experience, can handle a steam pumping plant.

C. R. Knowles:—There seems to be some confusion with regard to the question of boiler inspection four times a year. The statement in the paper just read is correct, not only for Illinois and Indiana, but throughout the United States, so far as the United States Railroad Administration is concerned, because their mechanical department circular, No. 11, I believe, calls for an inspection of boilers four times a year. Then, too, in regard to the relative values of the internal combustion engine and the steam engine, I think we may be looking at it from different points of view. One may be inclined to look at it from the standpoint of the cost, and others from the fact that you do not have men to handle the repairs properly; while still others are confusing the lower grade oils with gasoline. When we take exception to the points we ought to state more clearly whether we mean gasoline, kerosene, or low grade fuel oil engines. So far as I am concerned, I use nothing but the low grade distillates, which cost us about eight cents per gallon in tank car lots.

J. P. Wood:—I am of the opinion that, where you have a small pumping station with a drop spout tank where you are not using a great deal of water, the oil engine is more economical than a steam plant. I call to mind two such stations on my division which are operated by section foremen, with very little trouble. We have two good men there, and it is very seldom that I have to send anyone to make any repairs to either one of those engines. One is a gas engine, and the other is kerosene. But I do believe where you are using a considerable amount of water, and have standpipes, the steam plant perhaps is more economical, taking it from the standpoint that I have to consider, for I pipe the exhaust steam to the frost-box and from that to the standpipe. I have it so arranged that we can pipe the exhaust steam through there, and live steam too, if necessary. In this way we keep those plants thawed out in extremely cold weather, and escape the trouble of their freezing up through the neglect of some fireman who leaves a valve slightly open so that the water drips out enough so it freezes in time. We had that trouble before I solved it by pumping the steam in there. There are places where the pumping plant is too far away from the tank to do that, but where it is within a reasonable distance this can be done successfully. I believe that in both places, where you can get the live steam or the exhaust steam to the spout and standpipe and keep them thawed out in extremely cold weather, that the steam plant is more economical, for it saves the expense of sending men there from headquarters many times to thaw them out, where you have no plumber who can or will do it.

R. C. Young:—I would like to get the experience of some of the members regarding the use of the vertical type of kerosene and gasoline engines. We have several small ones on which we have installed carburetors and we find that the condensation from the kerosene gets into the lubricating oil and adds to the expense to such an extent that it offsets all the saving there is in the cheaper fuel.

J. L. Pickles:—Referring to the remarks made by Mr. Young, I will say that we have installed quite a number of kerosene carburetors on our gasoline engines and we thought we were making a great saving, but we find that we have to rebore the cylinders in from 3 to 6 months and we are therefore considering very seriously abandoning the carburetors and returning to the use of gasoline. We would do so if it were not that the shrinkage of gasoline is so great.

The Secretary:—There is, of course, a much greater shrinkage in the handling and use of gasoline over that of kerosene.

If the kerosene carburetors are properly applied and adjusted there is no need of reboring of cylinders as often as Mr. Pickles states. We have in use on the Chicago & Northwestern over 100 kerosene carburetors on gasoline engines which are working successfully and I do not find that we have to rebore the cylinders any oftener than when we used gasoline. There is certainly a great saving in the operation of kerosene carburetors on gasoline engines.

C. R. Knowles:—I can't see why we should consider the steam engine simply for the purpose of keeping the penstock free of ice. It seems to me that the question of frostproofing the tanks and penstock pits is more a matter of design. We have penstock pits and frost boxes, etc., throughout Iowa and South Dakota, with which we have very little trouble from freezing. We do have some of them frozen once in a while, but that is merely the result of carelessness. I have some figures on the comparative cost of operation for a steam and oil plant. The figures were collected at a plant which was only recently changed from steam to oil. It is not a small station, but is one delivering from 250,000 to 300,000 gal. of water a day on our main line between Chicago and Cairo. The cost of operation for the 12 months prior to the installation of the oil equipment was $4,027. The estimated cost of operation, based upon the first couple months' operation with the new plant is $2,200 per year. However, on checking up further we find that the expense is really going to run less than the estimated amount. The cost of coal for the steam plant was $1,600, while the cost of oil is going to run less than $800. The steam plant required two pumpers working ten hours a day each, which made a total cost of well over $2,000 for wages. The oil plant is handled within eight hours by one man, without overtime. Of course the saving depends on what you pay your pumper, but it aggregates about $800 or $900. The cost of unloading coal was nearly $700, for it had to be unloaded from the main line. This is an example of what can actually be accomplished in a large station. There is one consideration that I am afraid many lose sight of, and that is the fact that under present conditions we have to do our work within eight hours or pay penalty time. That is where the oil engine has a great advantage. Of course, you will have to build your units larger. These particular units are 500 gal. units, and we also have sufficient storage to handle a day's supply of water within eight hours. I merely present these figures to show that the saving is not only in the small station that you can operate with the agent and the section foreman, but in the larger stations as well. Also it appears to me that one can do a lot of frostproofing and frost protection work for $2,000 a year.

G. W. Andrews:—I would like to ask Mr. Knowles just how he reached the conclusions as to the vast difference in the expense of operating the steam plant he speaks of as compared with the gasoline or oil plant? He gives one item of two pumpers working 10 hours a day each, or a total of 20 hours, and for the oil pump he gives a time of 9 hours. We must naturally assume that if he pumps a sufficient quantity of water in 9 hours with the oil pump as against 20 hours for the steam pump, he is using a much larger unit in his oil pump.

C. R. Knowles:—That is correct.

G. W. Andrews:—Now, then, if he installs a coal burning unit of the same size it would enable him to pump that same quantity of water which would, of course, eliminate one pumper, or 11 hours, which should be considered in that comparison. If he has a 500-gal. oil unit, and a 200-gal. steam unit, his comparisons are relatively unfair. He should draw his comparisons between pumps of the same capacity as far as the labor is concerned.

As you know, the B. & O. is among the pioneer railroads in this country. We have used every type and style of pump that has been made, even starting with the original lifting of the water by a bucket from the first stream the engine would reach after running low, and placing it in a barrel, which was the tank supplying the locomotive with water. From that on to the hand pump, such as we still use, and as the Egyptians used 4,000 years ago, the plain trough with a wooden stem on the end of it. It would push down as much water as it pulled up, but still that is the kind we used. Today we are using modern pumps of every type that have ever been made in this country, steam pumps, gas, gasoline, and fuel oil. There are a number of cases where we have found it of great advantage to use gasoline or the fuel oil for running the pump, with an increased saving by the installation of the kerosene carburetor on the gasoline pumps, which we have been exceedingly successful with, reducing the cost of operation nearly 50 per cent.

About 20 years ago when the gasoline pumps commenced to be popular, even the manufacturers did not at that time claim any great economy in their use except where they could be operated by an employee who also had other duties and whose salary was therefore divided according to the work he did, which in many cases brought his salary as pumper down to as low as $10 a month. In some cases we paid him $10 additional to what he was being paid as a truck man or as an assistant around the station, or in other duties which would enable him to devote part of his time to the operation of the gasoline pump.

There are many places in which the gasoline pump is not practical. We have pumping stations which are flooded at various seasons during the year. I don't believe any of us would say that it was practical or economical to undertake to operate an oil burning pump or a gasoline pump under water, but we could still use the steam pump. We have one stretch of 100 miles of road which has been under water five times this year. There are five water stations on that 100 miles. Some of those stations have been as much as 20 ft. under water. You can see the position we would have been in if we had gasoline installations there. As a whole I would say that the use of either steam or gasoline should be governed by local conditions, and the ability to economize more than anything else. We can operate gasoline pumps under normal conditions with economy providing we can have an operator do it at a reduced salary, or be paid the pro rata of his salary for the time devoted to the work.

Again, the question of ability to get coal enters. We are in a soft coal country and in a large percentage of the cases the coal that we use in our water stations is coal which we get for practically the cost of cleaning it up, and we have to clean it up anyway. It is coal which has been discharged to locomotives and has fallen on the ground. Where you have to haul your coal long distances and pay large prices for it, in the open market, gasoline and fuel oil are the fuels to use. They will possess very material advantages in cases of that kind.

C. R. Knowles:—I don't think I made myself quite clear in my comparative statement of the expense of operating the stations. These are the actual figures taken from the books. I neglected to state that we have duplicate units at our main line stations, each of 500 gal. capacity. The same thing is true of our steam plant. It was a 500 gal. pump—that is, it was rated at 500 gal.; but as a matter of fact, as you all know, we rarely got more than 350 gal. As Mr. Andrews says, it is probably not fair to give the full credit for the saving to the operation of the gasoline engine, although the great part of it is due to the installation of the engine. That type of unit made it possible. With the duplicate units, there are times where we have to use both engines, which means that we can throw between 800 and 900 gal. of water. I think you will agree that an expenditure for a steam plant of that capacity, that would even approach 60 per cent of the efficiency of an oil engine would mean an expense much greater than that for the installation of oil engines. Not only that, but with a plant of that kind you would have to have a more experienced man to operate it, and you would have to give him four hours a day additional for taking care of his coal, cinders, boiler feed pumps, firing up, cleaning fires, and similar duties necessary in the operation of a steam plant. It is difficult to get the exact figures on the saving. With the steam plant we used about 16 to 18 cars of coal a year, while with the oil plant we use one car of oil; and not only that, but there was a saving that cannot be figured in dollars and cents, from the elimination of interruption of the work of the track men.

Mr. Andrews was speaking of the low cost of coal. This particular station is in the midst of the St. Louis coal fields, but we pay the same price for coal at this point that we do other points maybe seven hundred miles away. Probably Mr. Andrews has a different condition.

Mr. Andrews also speaks of the coal wasted at tipples. That costs just as much as the coal unloaded in the pump house coal bin. It may not be charged to the water station, but the railroad paid for it, and I think any saving that might be figured in that connection would be merely a paper saving. Also, if the railroad thoroughly equipped with coal tipples is wasting enough coal to keep the water stations going, I think there is an opportunity for some improvements in the handling of coal at the tipples.

G. W. Andrews:—I am fully aware that Mr. Knowles pays the same price at the mine for his water station coal as he does for any other coal that is used, on the railroad, but he has the long haul from his mines, which, in some States he admits is 700 miles. Now as to the use of the coal from the tipples, as you all know, we have to clean it up anyway. They object to our putting it back into the coal tipples for locomotive use, and the larger power plants dislike to use it, so in order to avoid throwing it away we use it very successfully in the way I stated. The cost of cleaning it up is not properly chargeable to the water stations, because we have to clean it up anyway.

When the price of gasoline went up as high as 28 cents we were forced to either go back to steam, or to install kerosene carburetors on our gasoline engines, which, as I stated before, we are still operating successfully, or to enter into the use of the fuel oil engine, several of which we have installed, and are operating successfully and economically. I don't want it to be thought for a moment that I am arguing against the use of gasoline or fuel oil engines where the local conditions necessitate the installation of a plant of that type, but I do say that we cannot consider them for use in all stations, eliminating steam plants entirely, until we find some way of operating fuel oil engines under water. As long as we can keep our steam supply out of the water, we can operate our pumps under water.

Another thing that we should consider is the fact that the ordinary steam pump can be repaired or replaced by the ordinary pumper until it gets in a condition that it is ready for junk, and if he doesn't know how, he can be taught how in a very few hours. The gasoline pump with its many intricate parts requires a skilled mechanic to take it apart and put it together again, and many of our pumpers are unable to do this.

C. R. Knowles:—Replying to Mr. Andrews' remarks in regard to operating pumps under water, it is true that a steam pump will operate under water, but not with any efficiency whatever.

G. W. Andrews:—It gives you the water, which you would not get otherwise, and which you have to have.

C. R. Knowles:—That is true, but you get a very low efficiency by operating a steam pump, or any other pump under water. We have oil stations operating on the Ohio and the Mississippi rivers, as well as the Big Muddy in Illinois and the Obion and Forked Deer in Tennessee, and if there are any wilder rivers in the country than the Big Muddy, the Obion and the Forked Deer I would like to see them. In a single night the elevation sometimes varies as much as 60 ft. We have one steam plant that it is necessary to operate under water every year. In installing our oil stations we put the pump in a frost-proof pit, and drive it from an oil engine located above high water. We have a difference of 34 ft. between high and low water at Baton Rouge, La., on the Mississippi river, and at Graveswitch, Ky., on the Tennessee river, we have a difference of 60 ft. between high and low water, but at this point we have our pumps in a water-proof pit. It is a triplex pump driven from a power head located above high water. In that case there would be no difference between the steam pump and the oil pump operating under water, except that the oil pump would show the highest efficiency because you would not have the loss from condensation. If you are going to put in an oil or a steam station, you should locate the pump so it will not be flooded, if you are going to expect full efficiency.

L. A. Cowsert:—After the coal reaches our side-track we have to haul it a half mile to the water station, which costs about three to five cents a bushel. We secure a saving by using oil with a gravity flow from the side-track to the water station. At all such stations we are using oil engines with a storage tank at the side-tracks, so that we can connect a 2½-in. pipe into the oil tank and fill the storage tanks, then run a small line a half mile to the water station, and have another small storage tank at the engine. This is all gravity flow. In this case we effect a saving of fuel of 50 per cent, while we save more than 20 per cent on the cost of fuel oil over steam, where we can unload the coal at the station. This has been demonstrated for about five years. We have had experience with gasoline engines with coal oil carburetors, and also with the two cycle engine burning fuel and coal oils, which I think is the most economical type that we have found.

In regard to the operation of a pump under water, I also have had that experience and I think that it would be very expensive in any station to operate a steam pump under water; while it is sometimes expensive to get the pump away from there, you can put the pump in a pit, as Mr. Knowles suggested, and operate it with a belt drive. We have a centrifugal pump at Williamstown, Ky., in a 20-ft. pit, operating with a belt drive from an oil engine two feet above high water level. I agree with Mr. Knowles that the oil engine shows a saving of fuel. We are in a coal region too, where we can get coal easily, but the expense of handling this coal after we get it is increasing every day with us. In all of our stations where we can change to oil engines in the future, we are going to do it.

E. A. Demars:—At the present time we have an inexhaustible supply of coal in the United States, but the supply of oil is continually getting more scarce, owing to the increased manufacture of different kinds of fuel engines. On one or two roads throughout the West they are seriously considering changing from oil back to coal. I consider that the changing out of steam plants to gasoline plants in certain locations throughout the United States would be more costly than keeping the steam plants in operation, owing to the increase in the cost of fuel oils at the present time.

F. M. Case:—On our road it has seemed that the installation of oil burning engines was more economical than coal. A coal pumping plant is a very wasteful thing, especially with a duplex pump. I think a triplex pump, operated by an expansion engine, would usually be more economical. The direct-connected gasoline plant doesn't seem to be just what we want. We are transmitting the power by belt, believing this to be much better than direct connection, but of course the relative efficiency of the two methods depends on certain local conditions.

G. W. Rear:—Burn equal quantities of fuel oil in an internal combustion engine, and under a boiler, and you will find a great saving in the internal combustion engine. However, that does not mean that a dollar's worth of fuel is going to produce the same amount of power. Some people may be able to get the coal by scraping it up; others may have to buy it and pay $17 or $18 a ton for it, the same as we do. Again, it is absolutely useless to attempt to compare a modern gasoline or oil engine with an old steam plant that is about ready to be scrapped. I have seen some roads get hold of an old boiler that was not of much use anywhere else, and a simple steam pump, and connect the two up together. The result is that the boiler is eating up more coal than it ought to, to provide a certain amount of steam, and the pump is eating up twice as much steam as it ought to, to supply the amount of water. The cost of the water is what it costs to get it into the tank.

Then there is the question of attendance. All plants have to have some kind of attendance. It may be that one can fix it up with either a steam plant or an internal combustion plant so that it may need comparatively little attendance. Very often a pumping station is just outside a roundhouse where one can take the steam from a central plant and the running of it costs practically nothing. In that case one ought to put in a modern plant, with compound pumps, and use the steam as economically as he can. With the gasoline plant one may have to have just as much attendance as with the steam plant. The plant may be located 50 miles from nowhere and the attendant has to live there while his only source of revenue is the running of that plant. I recall an ingenious installation located on a section of track 50 miles long on our road, that was intended to be electrified as soon as it was completed. During the construction of the four water stations on it they employed a pumper with a motor car. He started out in the morning, starting each pump as he came to it. A trip connected with the ignition system shut off the engine automatically when the tank was full. After having his lunch he came back and started them all up again. When the tanks were full again the trip would shut off the power. That worked out all satisfactorily for about 18 months, and they pumped a considerable amount of water.

It is a scientific fact that the internal combustion engine uses its fuel much more economically than the steam plant, but it is also useless to compare a modern internal combustion engine with an old plant that was hurriedly gotten together. It is possible to get together a steam plant that will give the internal combustion plant a hard run for its money, especially where you can get coal at a very low price.

C. R. Knowles:—Some may have the wrong conception of the comparative increase in the cost of fuels. I don't think you will find that oil has increased to the same extent that coal has. I heard someone remark about an inexhaustible supply of coal. I don't think there is an inexhaustible supply of coal nor an inexhaustible supply of oil either. I am not prepared to say what supply of either there may be in the earth, but I do know that there is a constant increase in the number of autos in service and that today you cannot buy one under six months' delivery, and the auto is using an oil similar to that used in our engines, so I don't think we need to have any fear as to the supply of oil being exhausted. If it is, I think there will be some substitute that will answer quite as well.

J. T. Andrews (By letter):—Considerable stress is laid upon the value of the fuel oil engine as compared with steam pumping. I believe that there is no question as to the value of the fuel oil engine for use in pumping plants under certain conditions.

Where a new installation is being made and especially, if local conditions are such that partial attendance can be had, the fuel oil installation will be much more economical than steam.

One feature, however, which is usually overlooked in discussions relative to the installation of internal combustion engines, is that it is often impossible to assign a competent man to do pumping during only a part of the time. The practice of having station agents, baggagemen, etc., look after pumping equipment, very often results in serious damage to the pumps and engines, due to the lack of proper attention, and it will usually be more economical to pay a full time pumper rather than to run the risk of breakdowns and serious delays due to such causes.

Fuel oil engines are expensive and unless a saving in the labor charges can be made, their operation is no more economical than steam at our present prices. Gasoline at present market prices is entirely out of the question, as the high cost of fuel itself will probably more than overbalance any saving which can be made in labor charges. The use of kerosene, however, is to be recommended, either in an engine built for that purpose, or in a gasoline engine equipped with a proper carburetor, in such cases where any part time pumper can be used. I do not, however, consider that kerosene installations are of as much value as fuel oil, except for comparatively small plants of light horse power.

In general, I would not recommend the changing of existing steam pumping plants to either fuel oil or kerosene, unless it can be shown clearly that a decided saving in labor can be made without consequent detriment to the pumping equipment through improper maintenance or operation.

Another point which should be considered is that steam pumps, especially the smaller and simpler types, can usually be kept in fairly good repair by the pumpers themselves, while internal combustion engines generally require a large amount of maintenance by expert mechanics. Probably the most undesirable present feature about steam plants is the necessity for having regular boiler inspections made under Federal laws, and unless the charges attendant thereon are kept under proper control, this is liable to result in a very heavy charge for boiler inspection.

PAINTING METAL RAILWAY STRUCTURES

Report of Committee

Questionnaires were sent to seventy railway officers asking for information on the subject assigned to this committee for consideration, from whom we received seventeen replies.

Naturally the first operation in the painting of a structure, and one which should receive a great deal of attention, is cleaning. The greatest enemy of steel is rust and to make a job of painting successful the rust must be thoroughly removed. All of our correspondents specify scrapers, wire brushes, chisels, and bars for this purpose, and three use the sand blast occasionally. There can be no doubt that the sand blast is by far the most thorough method of cleaning, but the cost is excessive and it is not generally used on that account. Some of our correspondents specify sledges and bars for the removal of rust, but it would seem that a structure that is so rusty as to require such heroic treatment would be seriously weakened and would indicate faulty methods of inspection.

All are agreed that the first coat of paint should be applied as soon as possible after cleaning, providing the steel is dry, as paint will not adhere to a wet surface. The use of sprayers is not advised, 16 of our correspondents reporting unfavorably while one says he believes it to be as good as brushing but remarks that he has had no experience.

The operation of brushing is of vital importance and should receive more attention than it usually does. We find in various instructions issued on the subject of steel painting that none but good mechanics should be employed; this brings up the question of what is a good mechanic. Because a man is a good house or carriage painter, it does not follow that he is a good steel painter; in fact, the opposite is found to be the case in many instances. In painting steel only enough paint should be used to cover and that should be thoroughly brushed, mixing it with whatever rust or other impurities may have been left on the surface and working it into all crevices. The thorough brushing of paint on steel is essential as rust begins to form as soon as the metal is exposed to the air and the brushing will tend to mix and incorporate whatever rust has formed with the paint. The best results are obtained by the use of brushes that have been worn considerably, as the temptation to lay the paint on too thick and then smooth it out is very great when using a new long bristle brush.

Some are inclined to advocate the use of the round brush, but the shape of the brush does not make much difference if the bristles are not too soft and long and sizes are used which will enable the painter to reach all the interstices as well as the broad surfaces.

The question of the material to use for the different coats was answered by 13 of the correspondents in favor of red lead in some form for the primer. While there are a number of inhibitive pigments on the market, none enjoys the popularity of red lead for this purpose. One correspondent favors the addition of white lead in the proportion of one-third white to two-thirds red; another advocates the addition of one per cent of lamp black with the idea of filling voids in the coarser red lead and tending to make the paint denser and more impervious to moisture. The addition of litharge was advocated in one instance but we are informed that litharge is contained in all red lead and is considered an impurity. A proprietary paint is used by four of our correspondents.

For the succeeding coats the preference is about equally divided between lamp black and graphite, while two report the use of brown mineral with satisfactory results.

The method which seems to be giving the greatest satisfaction and to be followed most universally is to prime with red lead, the second coat to consist of a mixture of red lead and lamp black and finish with lamp black and graphite. The object of mixing red and black so as to make a brown for the second coat, is that, it being a different color from either of the other coats, it is easier to see when the work is covered; and the addition of the finer pigment to the coarser makes a better paint on account of its greater density.

Only one of our correspondents reports the use of any other oil than linseed; in this case soya bean oil receives favorable mention.

The addition of about six per cent of turpentine is recommended in nearly all cases to assist in penetration and to give the paint better spreading qualities. This is not to be considered a substitute for linseed oil, but is added to the paint for a specific purpose.

Climatic conditions have a great influence on the durability of paint; the temperature does not seem to have much effect as we have reports from the high cold mountains of Montana and the low hot valleys of Arizona in which the life of similar paints is identical; although the temperature is from 50 to 60 deg. apart most of the time. The shortest life of paint is reported from the coast regions where the atmosphere is damp and warm and impregnated with salt, where in some cases painting must be done every year. The longest life of paint is reported from Montana and Texas, in which territories 15 to 18 years elapse before it is necessary to repaint.

For experimental purposes, one span of a seven-span deck plate girder structure over the Snake river at Idaho Falls, Idaho, was painted with a proprietary paint composed of some bituminous substances while the remaining six spans were painted with the regular standard bridge paint, composed of red lead, 10 per cent, lamp black, 50 per cent and inert material, 40 per cent; the vehicle specified to make a paste being raw linseed oil; boiled oil was used as a thinner in the field. Whether the linseed oil was kettle or bunghole-boiled we do not know, and we are equally ignorant of the composition of the inert material. The standard paint has made a good showing for itself, being in perfect condition after ten years of service, while the bituminous paint has disappeared except a light layer of black dust which was easily removed with a scraper and duster. The primer used on this bridge was red lead and linseed oil, and it must have been applied exceptionally well for, although the bituminous coating has practically disappeared the steel is in perfect condition, no rust spots having developed.

The materials used on water tanks and coaling stations do not differ materially from those used on bridges, except that in a few instances the inside surface of water tanks has been painted with hot tar.

The replies to the question whether water tanks need painting oftener than other structures are equally divided, seven declaring that they do and seven that they do not. Some extra precautions are necessary to prevent rust at the footings on account of the spilling of water from engines, in most cases an extra coat of paint being applied. Where a pocket is formed by the plates at the bottom of the pillars, filling the pocket with cement concrete is an excellent method of preservation.

No satisfactory results have been reported from the use of special coatings on coaling stations, ordinary bridge paint giving as much protection against the fumes of engines as any special preparation that has been tried. No preparation to be used as a paint can give adequate protection to overhead members subject to the direct blast from locomotive smokestacks; all such members are better protected by a cement covering or a suspended slab of asbestos or other indestructible material.

The question of painting galvanized iron brought out a great many formulas for washes to be applied to the iron before it is painted. These washes are supposed to prevent the paint from peeling, but none of them have any very enthusiastic advocates. The most successful method seems to be the weathering of the iron until the zinc coating is removed. If it is necessary to remove the zinc coating from the iron before it can be painted successfully, the zinc may as well be saved and plain iron used instead. The following chemicals are quoted as being used on galvanized iron for the above purposes: sal soda, sal ammoniac, hydrochloric acid, copper chloride, aqua ammonia, copper sulphate, nitric acid, benzine and turpentine.

C. T. Musgrave,
Chairman.

APPENDIX A

PROTECTION OF METAL STRUCTURES

By J. R. Shean, Pacific Electric Ry., Los Angeles, Cal.

The protection of metal structures is a subject which may be discussed in two parts—the first treating on steel structures, and the second, galvanized iron.

The protection of steel structures, which include bridges, structural steel and steel water tanks, is the great problem, as hundreds of thousands of dollars of every railroad's capital are invested in them. As their renewal, especially of bridges, is a very costly operation, on account of the necessity for doing the work without interfering with traffic it must be apparent to all that steel work should be started on its career of usefulness in the very best condition possible. While, in some instances, special treatment and material may be necessary on account of atmospheric or climatic conditions, as a general rule the same methods can be used for protecting all steel work.

The greatest enemy of steel is rust. Research and investigation have proved pretty thoroughly that it is caused by surface impurities, which may be carbon, cinder or oxide, and which, when the surface is wet, set up an electrolytic action that first starts the rust on its career of destruction. As long as it is left on the surface, it will continue to eat its way into the steel, until in the course of time, the whole structure will become so weak as to be unsafe for use.

Coats of paint will naturally retard the rust action by keeping the dampness away from it, but no paint has ever been made that will entirely kill rust as long as there is steel for it to act on. Bearing this in mind, no one can doubt that the money spent in cleaning the rust off thoroughly, before painting a new bridge, is money well spent. After years of practical experience, it has been proven that this work can best be done by the company's own forces as they have the structure to maintain afterwards and realize that a little thorough work done by them at this time will save a great amount of hard work and the company's money later on.

As a rule when the steel is new the rust consists of only light yellow spots here and there, and can be removed with scrapers, made from old files turned over at the end and retempered and sharpened. Stiff scrapers and putty knives are also useful at this time. Steel brushes are not of much real value, except to clean off dirt and loose mill scale. Any heavy seed rust which has formed a cup down in the steel should be chipped out with a hammer, and the greatest care should be taken, to be sure and get all the rust out of this cup so that the clear steel shows in the bottom. Care should also be taken to avoid cutting the steel unnecessarily with the sharp edges of the hammer. The sand blast is a very thorough way of cleaning steel at this time, but it should be followed at once with the first coat of paint, as the surface starts to rust again very soon after the blast is used.

After the surface has been thoroughly cleaned, the next question is what to use for a first coat of paint to give it the maximum protection against the rust getting another foothold. There are several "inhibitive" pigments, most of which are impractical for general use. The one which is generally accepted by engineers as being the most valuable is red lead. This pigment has had many enemies among engineers and painters on account of its tendency to sag and run on vertical surfaces, and to settle into a hard concrete-like mass in the bottom of the container. These faults are caused by an excessive amount of litharge, which sometimes amounts to 30 per cent of the cheaper grades. In the last few years, some lead manufacturers, by finer grinding and reroasting, have reduced the litharge until the United States Government standard is true red lead 94 per cent and litharge 6 per cent. More improvement has been made, however, and now it is possible to buy red lead containing only 2 per cent of litharge, and 98 per cent true red lead (Pb_3O_4). This makes an ideal paint for first coat. Being extremely fine, it fills all pores, and brushes out in a smooth even film, free from voids. It stays in place on vertical surfaces and does not act ropy under the brush.

Another great advantage in using this high grade material is that it can be bought in paste form, saving the time it used to take to mix up the dry red lead by hand. The vehicle with which the red lead is mixed is fully as important as the pigment itself. The merit of linseed oil is too well known to need comparing with any other for this work, although the paint film is much better if reinforced with Japan oil. Elaborate tests, made recently, have proven that without reinforcing an oil film loses from 18 per cent to 23 per cent of its volume in 200 days.

This shrinkage of the oil film, which should hold the pigment together, is worthy of serious consideration and Japan oil or anything else which will truly reinforce it, should certainly be used. Japan oil also furnishes sufficient dryers of the right kind, as rosin dryers are a detriment rather than a help to red lead.

The amount of red lead to be used in one gallon of vehicle is a question upon which engineers differ. On the Hell Gate bridge, 37 lbs. of red lead were used to 1 gal. of vehicle, but this would only be possible with the very finest quality of red lead. The general average for railroad use is about 25 lbs. to the gallon of vehicle, or about 17 lbs. to the gallon of paint mixed and ready for use.

When steel work is to be red leaded at the fabricating plant, care should be taken to have the specification worded in such a way, that no misconstruing of its intention will be possible. In any case, the inspector should make it a point to see that the intention of the specification writer is carried out.

The coats of paint to succeed the red lead and to repaint the structure when necessary form a proposition upon which there is considerable difference of opinion. Some authorities insist that a carbon base is the best, others insist that graphite is, while others prefer mineral red or lamp black. Whatever the individual merits of these pigments are, and they probably are all good if applied right, the fact remains, that they are all heat attractors. As heat is a first class destroyer, it is hard to understand why it has become such a common practice to use these dark colors.

Unless the price of material is the main consideration there is no reason why steel work should not be painted in light colors, as their resistance to heat rays would certainly be easier on the oil film which holds the pigment together, than the dark colors which attract and hold the heat rays.

Canary yellow, pearl gray or light olive green will change an unsightly black structure to one that will at least be more in harmony with its surroundings. These light colors will last longer than the dark colors to pay for whatever difference there is in the cost of the two. It may be argued that light colors become unsightly in a short time from dirt and smoke. This cannot be noticed to any extent except overhead on through truss bridges and on overhead bridges, but even if painted black the smoke marks show considerably on this part of a bridge. The theory to follow when applying the coats which follow the red lead, as well as any other time the bridge is painted, is to have the last coat of paint more elastic than the coat preceding it. This will insure against checking and alligatoring. Some authorities advise putting a little non-drying oil in the last coat, to make a better "shedder" of water. This would appear to be a good plan, provided it finally did dry hard by the time the bridge had to be repainted, so that the next coat was more elastic, thus avoiding the danger of checking.

A brushed-on coat is very much superior to one applied with a spraying machine on steel work, as the protection of steel depends largely on whether or not the paint is thoroughly brushed into the pores and then laid off in a smooth, even film. A spraying machine cannot do this, and while it is a timesaver, when applying varnish or a flat color and water colors, which flow out of their own accord, oil color has to be brushed to give the best results on steel. Some advocate spraying and then brushing. This does not solve the problem, as the brushing in this case generally consists in drawing the brush over the surface once and smoothing it out. If work is sprayed and then brushed as much as it should be, the only saving is doing away with the necessity of dipping the brush in the paint pot. The practice of painting a bridge with a four-inch brush and perhaps one sash tool is a very poor one. Different kinds of brushes should be furnished and the workmen should be required to use them, to get the paint in every nook and corner and between angle braces, etc. It is in these inaccessible places that rust does the worst damage if once allowed to get a foothold.

The tools needed for cleaning the work before repainting are about the same as for new work. Light chipping hammers are indispensable for getting the rust-scale off. For cleaning the dirt off, a small bunch of broom corn wrapped with twine, makes a very handy tool. After the dirt has been loosened with the broom corn, it can be brushed off easily with the duster. This saves considerable scraping with the putty knife.

If a structure is properly treated when it is new, there is hardly any need of using a sand blast for repainting. The rust will only show where it is able to push the paint off and these spots should be chipped out until the cup formed by the rust shows the clear steel. Holding the blast on one of these spots until the cup is clear of rust will cause considerable unnecessary cutting of the steel around it. After the rust is cleaned off, the bare places should be spotted with good red lead and then painted the same as the rest of the bridge. If this work is done thoroughly there is no reason to expect further trouble from these places, but if it is not, it is only a matter of a short time until the rust will be at its work of destruction again. On overhead structures, where the hot cinders from the smokestacks strike with considerable force, no paint can be expected to give the needed protection without some sort of a fender for them to strike against.

After the painting is done something should be devised for this purpose and placed over the tracks to take the full force of the sparks. A great deal of harm is also done around bridge seats by the dirt and cinders which are generally allowed to gather on the abutments for when this mass gets wet, an acid is formed, which not only ruins the paint film, but also induces rust action. On every road some one should be responsible for keeping the abutments clean, at least to the point of not letting the dirt accumulate until the bridge end is buried.

Steel water tanks should receive the same general treatment as other steel work. The additional cost of an extra coat of red lead on the inside of the tank is money well spent. A good quality of linseed oil reinforced with Japan oil should be used in the finishing coats on tanks as water has a tendency to soften the oil film, and, as every one knows, there is always more or less water splashing around. Pockets without outlets should be filled with concrete wherever it is practical to do so, especially at the footings.

Substitute oils are becoming very common now and some will do fairly well if reinforced, but the fact that at the best they are only substitutes should be borne in mind when using them, especially on tanks or near the coast where there is considerable dampness in the air.

The painting of new galvanized iron is a very unsatisfactory problem as the paint is almost certain to peel off in time. This may be caused by the hard, polished surface of the galvanizing not giving the paint a foothold. The same conditions are met in painting smooth aluminum. There is more or less impression among painters that the peeling is caused by acid on the surface, but such is not the case. The process of galvanizing consists of pickling the material until it is perfectly clean. After drying, it is immersed in molten zinc, heated to approximately 850 deg. F. until the material has attained the same heat; after being removed and cooled off it is ready for use. How any acid can remain after this torrid experience is a mystery. The acid theory for the cause of peeling is discounted by the fact that a wash made of one ounce each of copper nitrate, copper chloride and sal ammoniac crystals, dissolved in soft water and then one ounce of muriatic acid added will change the surface so that paint will adhere very well. This wash turns the galvanizing a dark slate color and probably removes a good share of the zinc coating, allowing the paint to get a hold on the iron itself. Whether it does or not there is more chance for the acid to affect the paint than there is after it has been heated to 850 deg. F. The wash described should be applied with a soft brush or a swab, and when it has dried, the fine powder which is left on the surface should be brushed off. Having in mind all the trouble and uncertainty regarding paint or galvanized iron the question arises in one's mind, why paint it at all? If for certain reasons a building has to be painted why not use straight corrugated iron and paint it for protection. The cost of galvanizing iron in a first-class manner is from three cents to five cents per pound and as every one knows the iron can be painted for less than that. If a galvanized iron building has to be painted when new, and it is impractical to apply the wash, a priming coat of good red lead with considerable turpentine in it will give fairly good results. Roughing the surface by rubbing lightly with coarse sand paper will help the paint to hold. The best system to follow is to let a structure covered with this material stand without paint until the galvanizing is about worn off by the weather, and then paint it before rust has a chance to form. There is no reason why it should rust if given a fair coat of paint, as the iron is perfectly clear of rust or dirt before it is possible to galvanize it.

APPENDIX B

By G. G. Mowat, Cleveland, Ohio

The specification prepared by the engineer and the chemist, for the purpose of creating an efficient protective covering on structural steel, is the result of considerable experimenting. The seat of the trouble is in the chemical affinity between iron and the oxygen of the air. Dry iron and dry air have no action upon each other at ordinary temperatures, but in the presence of moisture and the other gases contained in the atmosphere, a chemical reaction takes place with the formation of "rust," which is a hydrated ferric oxide, or iron oxide, and is much the same as a limonite iron ore from which iron may be extracted in the blast furnace.

The rust which forms in the oxidation, or hydrolysis of iron takes up almost two times as much room as the iron which it replaces, hence the paint or protective film will be pushed away. The rust is a moisture absorbent, and usually carries not less than 24 per cent of water held in its pores, which water acts as the source of further corrosive action.

Origin of Structural Steel

A few words about the origin of structural steel. The blast furnace is a pot or crucible into which is charged a mixture of iron ore, coke and limestone. This is subjected to a hot air blast. The air reacts with the carbon of the coke to form a lower oxide of carbon. This in turn, at the high temperature prevailing, takes oxygen away from the iron of the iron ore, and thus liberates the metal in a molten condition. This metal, known as "pig iron," contains much carbon, and air is blown through the still molten metal in an apparatus known as a converter. After having been changed to steel in the converter, the liquid is cast into blooms, and these may then be rolled and forged into structural shapes.

Owing to the high temperature at which the shapes are rolled or forged and the necessity of having this process take place in the air, each shape is covered with a coating of black magnetic iron oxide or "mill scale."

Now the peculiar thing about this "mill scale" is that it is quite inert towards the corroding action of a damp and smoky atmosphere, and hence, if it were not brittle by nature, but as tough as the steel underneath it, it would serve as a good protective coating for the steel. But some of it is bound to chip off during handling and transportation, and it always is the source of quick corrosion of the underlying steel when moisture and atmospheric gases furnish the go-between for the rusting process; for the mill scale and the iron constitute the positive and negative elements of an electrical battery and the moisture and acid gases furnish the vehicle for the electrolysis, which results in the attacking and removing of valuable iron substance. The engineer's specification therefore calls for a complete removal of all "mill scale," and this cannot be effective by the use of the whiskbroom and putty knife. Sandblasting, wirebrushing and pickling are three methods of removing mill scale and rust. The former are mechanical processes and the latter is a chemical one. The chemical process of pickling is an expensive one. Hot dilute sulphuric or muriatic acid, or mixtures of either of these with hydrofluoric acid, may be used for the pickling treatment. When the mill scale has been loosened sufficiently, the piece is removed from the hot acid bath, and subjected to a powerful stream of water, which helps to wash off the scum resulting from the process. The work must then be given a bath of hot milk of lime to insure removal of all acid.

It is then dried best by the use of artificial heat. The coating of lime is brushed off just before the metal is to be painted.

Sandblasting is more economical of space and labor, and practically any location is accessible to the sandblast, so that it is most frequently used.

After the surface has been thoroughly cleaned, so as to be practically a bright metallic one, the work is ready for the priming coat.

The careful removal of all rust should be followed immediately by the application of the priming coat.

What Paint Is

As we all know, a paint is a liquid consisting of a vehicle with a pigment in suspension. A few pigments have been discovered or are known to us, which take the place of the expensive Bower-Barff treatment. When in contact with the clean iron surface and in the presence of moisture these pigments produce a continuous insoluble, inert coating on the iron.

Such pigments in the order of their utility are: Chromates of zinc and of lead; red lead and orange mineral; and black oxide of manganese.

To know what kind of a paint is the best one to use for a given purpose, is a matter of experience, and experience is a hard taskmaster. It is well to know also a little of the theory why a certain deterioration takes place under certain circumstances and not under other conditions.

It is a recognized fact that the practical value of all protective pigments depends on their atomic fineness, density, favorable specific gravity, immunity from atmospheric influence, ready ability to amalgamate perfectly with linseed oil and remain in suspension during application.

Commercial Red Lead

Commercial red lead usually consists of about 85 per cent true red lead and 15 per cent litharge. If we remove the litharge chemically we may obtain a true red lead. A paint made up from this pigment and raw linseed oil will not dry properly, and a dryer or siccative must be added to attain a practical rate of drying. Litharge, on the other hand, combines or saponifies fairly rapidly with raw linseed oil.

It has been proved that red lead serves best when used on structures submerged in water, such as ships' bottoms, turbine wheels, channel and harbor signal devices, bell buoys, etc., for when exposed to the air and to contact with sulphurous gases it has a tendency to disintegrate rapidly. It has been found that superior inhibitive results joined with greater durability are obtained when a mixture of metal chromes, pure iron oxide pigment and powdered silica is used in the paint for the priming coat.

Ferro chromes are used by British manufacturers in making stainless steel cutlery. A formula that combines these constituents in correct proportion has long been recognized by authorities as a most effective and economical primer for iron and steel. Sulphurous gases and fumes from passing locomotives have a tendency wherever there has been an abrasion of the finishing coat on a steel bridge to disintegrate red lead when it has been used as the priming coat. This disadvantage is overcome in the use of a formula as outlined above.

Another point which has some influence on the durability of a paint film and on its non-permeability is the fineness of the particles.

No single coating will present all the features desirable in a protective film. Experience has, therefore, led up to the following practice:

1. Complete removal of mill scale, old coating or rust, as the case may require.
2. Application of inhibitive coating.
3. Application of first protective coating.
4. Application of second protective coating.

Experience has shown that it is productive of good results to carefully apply one or two shop coats of primer in oil, letting each of these set properly, then when the work is in place to go over and repair any deficiencies of the priming layers. The second coat should be slightly different in color, and contain some inert pigments and linseed oil, and a final elastic black coat of inert pigments and linseed oil is then applied. It is advisable that the inhibitive coating should vary in color from the protective coating—the difference in color serving to prevent imperfections in application.

The value of cleaning and painting structural steel is a material one in the total cost of completely erecting a structure. If it were not for the possibility of protecting steel structures with inhibitive and sealing coatings in this way, we would have to surround them with Portland cement or with nobler metals.

The rules for the proper protection of steel are not always observed, and millions of tons of steel structures are hastening to premature decay because of shortsightedness and skimping, while other millions of tons are at least fairly well protected.

APPENDIX C

Paper read before Houston Engineers' Club, May, 1919

By Tom R. Wyles

Protection for Steel Structures

The great need for the conservation of natural resources makes it more than ever necessary that the subject of the preservation of iron and steel structures receive most careful attention.

At the present time no absolutely permanent protection for steel is known and although paint is accepted as the most efficient protection, the subject is not always given the technical attention which it merits.

To obtain the maximum protection at minimum cost, it is necessary to appreciate the factors governing the situation. These are as follows:

1. The electro-chemical technical explanation of corrosion. (Accepted by the leading authorities as the true cause of corrosion.)
2. The condition of steel as it is turned out from the rolling mills.
3. Modern fabricating shop practice.
4. The requirements necessary for various exposures.

The electro-chemical explanation of corrosion, briefly stated, is as follows:

Every metal, when placed in water or in an atmosphere which acts as an electrolyte or in such conditions of exposure that a film of moisture may condense on it, tends to dissolve. This tendency is governed by impurities, unequal stresses and unhomogeneous nature of the metal in each case and by the impurities in the liquid or gaseous film. Certain points in the metal, which have varying tendencies to go into solution, form electrodes of opposite nature and corrosion takes place in proportion to the potential difference between these points, governed by the value of the electrolyte connecting them. The more concentrated the hydrogen ions in a solution (as in acids), the higher will be its electric conductivity and the more rapid, consequently, the corrosion of the underlying metal. It is clear, therefore, that in a fabricated structure this action between points applies to each surface in detail but to the whole structure of which the members are of varying composition or subject to varying stresses.

Owing to the process of manufacture by heat, steel plates and shapes are always coated with scale which is the black magnetic oxide of iron. This, though it has at first a metallic blue sheen, is not part of the metal, and as it is electro-negative to the steel or iron, it forms a surface which actively promotes corrosion from the moment it is exposed to the atmosphere. This corrosion is hastened in proportion to the amount of moisture in the air and any acid present.

The mill scale as it corrodes changes into a hydrated red oxide of iron holding 24 per cent of hydroscopic moisture which is never dried out under atmospheric heat conditions, but acts as an accelerator of further corrosion. As this change takes place the scale increases to more than double its bulk, gradually loosens and flakes off.

No paint applied on top of corroded scale, even though the oil penetrates the scale, will stop this corrosive action or bond the scale to the underlying metal. The paint merely acts as a covering under which the moisture in the scale will vaporize and creep. The increasing bulk of the corroding scale will lift the paint skin from the metal, breaking the waterproofing skin of the paint and the process of corrosion will continue. Once corrosion of the steel, therefore, is started greatest care should be given to cleaning the surface. It is better to have the mill scale corroded right off, as in marine practice where vessels are built on open ways and the hull is left to corrode during the construction period, than to only partially clean the surface and leave particles of corroded scale under the paint.

In shop practice, however, it is not always possible to remove entirely anything but the loosened or corroded scale. Blue mill scale adheres so firmly to the surface that it can be removed only by the use of a sandblast or by the pickling process. Either of these methods makes for excessive fabricating costs and, therefore, for general work the blue mill scale is left on, and only the corroded scale which it is possible to remove by the use of hammers, scrapers, and steel wire brushes is taken care of. Shop practice also is governed by the speed of production, the labor situation and the shapes of sections, all of which affect the amount of work which can be done on cleaning, and it is, therefore, necessary to design the first or shop coat of paint in such a manner that it will, by its anticorrosive and electro-chemical insulating qualities and by its adhesion, prevent corrosion from spreading and counterbalance the shortcomings of practical workmanship to obtain maximum results.

Information Governing the First Shop Coat of Paint

As the functions of this coat of paint are to take care of the electrochemical corrosive action outlined, to form a base on which the exposure or field coats are placed and to overcome in the most effective way possible the shortcomings on the conditions governing even the best shop practice, it is very necessary that this paint receive most careful consideration.

It must be composed of especially pure ingredients which make the paint thoroughly neutral and from which all free acids have been eliminated in order to avoid chemical action between the paint and the steel. The paint must also resist the passage of electric currents, as otherwise the steel will be subject to electrolytic action. It must protect the steel against the action of moisture or gases during its transition through the fabricating shops and for a period long enough to allow the steel to be erected, as otherwise corrosion of the surfaces is started before the exposure or field coats are applied.

It must dry hard with strong adhesive qualities, and yet be sufficiently elastic to resist handling of the structure through the shops and to offer an effective surface against the extreme ranges of our severe climates with 120 degrees Fahrenheit temperature range, otherwise after a short life it will crack and allow moisture to attack the steel.

It must be a reasonably light coat as otherwise when used as an assembly paint between surfaces in contact where hot rivets are driven it will burn out and cause loose rivets. It should be easily spread in order that it may be worked into all portions of a built-up section without difficulty by the shop labor.

One of the causes of high maintenance costs in steel structures is the practice of letting a structure stand exposure until not only the field coat of paint has lost its vitality, but corrosion has eaten right through the shop paint and bare portions of steel are exposed, thereafter applying one coat of field paint. It should be remembered that in many cases the most effective field coat is not a proper shop or anticorrosive paint. If corrosion is far advanced on a structure, at least two coats of paint should be applied after the surfaces have been thoroughly cleaned, and the first of these should be a real anticorrosive paint fulfilling all the requirements of a shop or construction paint. The second coat should be one which will protect the first coat and offer greatest resistence to the exposure to which it is subjected—i. e.. atmospheric-normal, atmospheric-acid fumes, under water, underground, etc.

Information Governing First Field Coat of Paint

The functions of this coat of paint are to reinforce the shop paint and to take care of any portions of the steel work which have been improperly covered or become scratched in transit through the works. It is good practice when surfaces are bare of paint, caused by transit, erection and riveting, these spots including new rivets should be wire brushed and painted before applying a complete field coat; otherwise, uniform protection is not given.

To appreciate the necessity for this coat, one has to have experienced the maintenance of steel structures on which it has not been applied or had access to practical exposure tests of paints. It is absolutely necessary on very light structures such as transmission towers where small thin sections are used in the construction, as the sharp edges of these are hard to cover properly with one shop coat and in such structures the varying nature of the stresses usually makes corrosion conditions extremely severe. It should always be applied where severe weather conditions exist such as strong sun, high wind, large variations of temperature, etc.

It must be strictly an anticorrosive paint similar to the shop coat but have in its makeup more of an oil life than hard drying properties as it must also help to reinforce and feed subsequent coats.

It should be slightly different color than the first shop to insure absolute covering.

Information Covering Exposure or Second Field Coat of Paint

The function of this coat of paint is to withstand exposure to which the structure is subjected, and consequently it must be designed to suit.

The whole value of the shop coats will be lost if the field paint is not suited to its purpose or if it is improperly applied. Wherever possible this coating should be selected to meet service conditions—viz.:

Atmospheric, general.—A good linseed oil paint.

Earth acids. Buried tanks, pipes, penstocks, etc.—Either a hard gum coating or well refined asphalt. No tar.

Alternate submersion. Turbines, lock gates, bridge piers, etc.—A special hard drying oil paint.

Acid fumes.—Special coatings are made for unusual conditions.

Salt spray and sea fogs.—Great care must be taken on previous coats. A good boiled oil paint well applied is serviceable.

DISCUSSION

(Painting Metal Railroad Structures)

J. L. Pickles:—I would like to take exception to the last paragraph in the report, which suggests waiting until the zinc coating is removed. You want to wait until the zinc is oxidized and then the paint will adhere to it. If you wait a couple of years you still have a coating of zinc that will protect the iron.

A Member:—Before painting galvanized iron we always apply vinegar and then wash it off, and we never have any trouble with our paint.

Mr. Ettinger:—The paper does not fully explain the use of tools. It merely says, "Use that tool." We give our men the tools and 95 per cent of my trouble, at times, is to get the fellows to use them. I have seen paint applied directly upon a heavy casing of rust. I found one by actual measurement only the other day, ⅜-in. thick. It is a waste of time and of material to spread good paint over a coating of rust, proving that the use of the proper tool is more necessary than the providing of the tool if you are going to leave it in the tool box.

" It would seem that a structure that is so rusty as to require such heroic treatment would be seriously weakened and would indicate faulty methods of inspection." To that, I believe should be added the words " or application."

Further down the report we read, " The operation of brushing is of vital importance and should receive more attention than it usually does." That bears out my remarks, and explains the non-use of the spray. There is very little absorption to steel. The surface is smooth, at times, and the only way you can get anything to adhere is to brush it in. A spray doesn't do that. It only forces it to the surface, and it then rolls down. Furthermore, in using a spray you have got to make your material so thin that you have to use volatile liquids, such as turpentine or benzine in order to force a rapid evaporation and to get the film to set. To do that you cut the life out of the paint. I wish that some spray could be invented to do the work, for one reason more than any other—to reach the inaccessible portions of bridges.

A further remark in that same paragraph calls attention to the fact that in painting steel, " We find in various instructions issued on the subject of steel painting that none but good mechanics should be employed; this brings up the question of what is a good mechanic. Because a man is a good house or carriage painter it does not follow that he is a good steel painter." That is a question for us men in the field to solve. We must make our mechanics. We must teach them this work. If we don't we are lax in our duties. The best all-round mechanics that I have are the men of my own training.

The next paragraph reads—" Some are inclined to advocate the use of the round brush, but the shape of the brush does not make much difference if the bristles are not too soft and long." That brings me back to the old days when we did use the round brush. Forty-five years ago the flat brush was not known; the round brush was the only one used, and it is the only real brush today. It contains more bristles than the flat brush; it contains more power; it covers more surface. Not long ago a so-called " old-time man " came to me for a job. I happened to have a ball of twine and a round brush lying on the desk. This fellow talked about being an old-time mechanic. I said to him, " Take this ball of twine and take this round brush and bind it up for me. Show me how you used to do it." He looked at me as if he thought that I was crazy. This fellow hadn't learned as much as he claimed, and the consequence was that he didn't get the job.

" The question of the material to use for the different coats was answered by 13 of the correspondents in favor of red lead in some form for the primer." That stands undisputed. Red lead has a natural affinity for steel. It is a so-called " inhibitive pigment." But there isn't as much in the inhibitive story as we think. There are many red leads in name, but high grade leads that do the real work contain from 94 to 98 per cent lead. Red lead and litharges are the same, litharge being the dryer or the coarse material in the red lead. The more of this litharge you take out, the finer the red lead becomes, the more oil you can take out, the easier it will brush, and the more affinity it will have for steel. About ten years ago government chemists asked for nothing less than 94 per cent of pure red lead, meaning that only 6 per cent could be dryer, or litharge. Red lead is, I believe, more extensively used than any other primer. I find in my experience, though, that a high grade ferric-oxide, containing from 85 to 92 per cent of pure oxide, comes very near to it. In days gone by we had to mix red lead by the batch. I remember the first job I did I could mix only half a day's supply at one time. That shows that at that time we didn't get red lead; we got more litharge or dryers. By noon that batch was putty; it dried up so rapidly. But since that time science has gotten away from that and today we can get the product that we want. You have to have red lead, not in name, but in fact. It must be at least 94 per cent. If you get anything below that, you have a coarse, rough coating, and you are going to have trouble.

" One correspondent favors the addition of white lead in the proportion of one-third white to two-thirds red; another advocates the addition of one per cent of lamp black with the idea of filling voids in the coarser red lead and tending to make the paint denser and more impervious to moisture." Here is a contradiction. Put lamp black into a bottle with a mixture of red lead and leave it stand and you will find the red lead at the bottom and the lamp black coming up, showing that it doesn't fill voids. It is put in there to darken the red lead; that is all. It is not a filler; it is too light for that. "The addition of litharge was advocated in one instance but we are informed that litharge is contained in all red lead and is considered an impurity." Litharge and red lead are identical. Red lead, before it becomes such, is litharge, or dryer. We take away the litharge, in order to make the red lead finer, to make it receive and take up more oil. It is the oil that really makes the life of the paint. The more oil we can squeeze into the body of the paint, the better we are off. Take, for instance, lamp black. In 100 lbs. of lamp black, you will find 80 lbs. of oil and 20 lbs. of lamp black. Compare that with 100 lbs. of red lead, which contains 93.5 per cent of red lead and only 6.5 per cent of oil. You have 80 lbs. of oil in the lamp black and only 6.5 lbs. in the red lead, showing that the lamp black takes up a great deal more. That is why we use black as our surface coatings. It takes up more oil and gives a film that is more impervious to water and easier of application.

"The method which seems to be giving the greatest satisfaction and to be followed most universally is to prime with red lead, the second coat to consist of a mixture of red lead and lamp black and finish with lamp black and graphite." We add a little black to the red in order to give us a guide. Supposing you let the bridge painting by contract and you want to see how the contractor applies each coat. You can then see a spot that has been missed readily and you can call his attention to it.

"Only one of our correspondents reports the use of any other oil than linseed; in this case soya bean oil receives favorable mention." It is the hardest thing on earth in these times, and will be for several years more, to get linseed oil, let alone soya bean oil, and soya bean oil is higher in price than linseed. Linseed oil has been known for ages, and nothing has been found in all the substitutes that may be advertised and that may be tried, that will beat it. We are looking for something cheaper; not something more expensive.

"The addition of about six per cent of turpentine is recommended in nearly all cases to assist in penetration and to give the paint better spreading qualities." We use turpentine for two reasons: to make it spread on the bridge a trifle easier, in order to save a little labor, and to give penetration. I am now talking about repainting old steel or old structures where we have old coatings on. The only way to do this is to anchor your old coats. If you don't, you will have a separation, and trouble. The turpentine is the material that penetrates into the old coating and forms a solid anchor, hooking up to the old coating that in some cases, no doubt, is hard and brittle. We even go sometimes to the use of benzol.

"The materials used on water tanks and coaling stations do not differ materially from those used on bridges." I expect this refers to steel tanks. Steel bridges and tanks are all subjected to the same climatic conditions, the same influences of air and moisture, and those are the two corrosive agents. What helps the one will help the other.

"No satisfactory results have been reported from the use of special coatings on coaling stations, ordinary bridge paint giving as much protection against the fumes of engines as any special preparation that has been tried." I believe I have tried almost every preparation that has been put out in this country and it didn't do any good. Our ordinary paint stands just as much as anything else.

"The question of painting galvanized iron brought out a great many formulas for washes to be applied to the iron before it is painted. These washes are supposed to prevent the paint from peeling, but none of them have any very enthusiastic advocates. The most successful method seems to be the weathering of the iron until the zinc coating is removed." When we talk about weathering we don't mean to let the iron go until holes are in it. The only thing we mean by that is to let nature do that which we might do in a quick operation by a coating to stop the action of the galvanization of the zinc which has been applied there. The white powder that you see on new galvanized iron will not bind to paint, and we will have peeling. You paint a sheet of galvanized iron with any kind of paint while the white deposit is on it and you will find that in six months it will open up and the first thing you know you can rip it all off, due to the fact that the zinc coating has stopped the combination between the iron or the steel and the coating. The most successful wash I have found is to dissolve about six ounces of copper acetate in one gallon of water; wash the galvanized sheet with it, let it dry, dust it off, and apply the paint, and you will have no trouble. That application removes the zinc film. But I wouldn't advise the use of it for it costs money to do that.

F. E. Weise:—When we were talking over the subject of painting in the executive committee meeting it was thought that the association might be interested in getting the view-point of some outsider, and we invited Mr. Mowat of the Sherwin-Williams Company to come over and talk to us. He is obliged to be out of the city today, so he sent Mr. Swaney to read his paper for him. I would like to call on Mr. Swaney now.

Mr. Swaney:—I am sorry that Mr. Mowat couldn't be with you today, as he is very familiar with our manufacturing problem and possibly he could have given you the information that will be useful in a much better way than I can. I am on the sales end of it, and while I must know my products well and put them up to our customers, I am not as familiar with the manufacturing end as Mr. Mowat has been. I have often wondered why a body of men such as yourselves could not get together and possibly reach a conclusion upon what was the proper formula for a metal protective paint. As it is today you will find that one railroad has a specification calling for a certain percentage of pigments, while another road has another, and another road another. When we bid on those, in figuring our costs, we necessarily have to figure on a special product for each road, whereas if they were manufactured under a certain formula the manufacturer could have that standardized with him and he would have the material in stock. I would venture to say that today he could cut your cost of materials from 25 to 50 cents a gallon if there were standardized formulas.

(For Mr. Mowat's paper see Appendix " B," following report of committee.)

H. S. Bird—(By Letter):—Some of the parts of a bridge that are most susceptible to corrosion are the horizontal surfaces where exposed to the heat of the sun and the extreme cold and moisture of the winter storms. These parts are generally the first to show signs of corrosion. The tops of girders are extremely hard to protect. They should not pass with an ordinary painting, but should receive special attention. Very good results can be obtained by first applying one or two coats of paint in the usual way and then apply a coat of roofing cement or pitch. This will serve to resist the weather conditions and protect the under coatings. Bridge columns at street crossings are subject to abuse and corrosion on account of the acid conditions (uric acid). Good results can be obtained with similar treatment. After receiving a general painting, a coating of pitch or acid resisting paint should be applied.

THE ECONOMICAL USE AND STORAGE OF FUEL AT RAILWAY PUMPING STATIONS

Report of Committee

In the operation of railroad pumping stations the fuels commonly used are bituminous coal, gasoline, kerosene and fuel oils. As fuel is a most important factor in the expense of operation, it is obvious that, both in storage and consumption, it should be used economically. To effect this, machinery should be well maintained and the most efficient types of equipment utilized.

Storage capacity should be gaged with reference to requirements. To avoid undue deterioration, coal should not be stored to exceed 60 days. The storage supply should be located outside of and at a convenient distance from the pump house, away from other buildings and near an unloading track where one is available so that coal may be handled direct from the cars. To avoid the retention of some portion of the coal in the bin for an indefinite time there should be two openings to remove the coal. A bin may be constructed of second hand timbers or of other suitable material, with walls just high enough to contain the coal. Where not more than 60 days' supply is carried, a roof is not essential; as the economy to be derived therefrom will hardly be commensurate with the cost.

Where plants are located below tracks, chutes may be provided to convey the coal from the unloading track to the bin. At isolated plants and where it is necessary to deliver coal by teams, a covered bin with a suitable approach may be utilized and supplied by dump wagons, driven over or backed on to the top as the case may be, and the load dumped. The kind of coal used should be that which will show the most economy and must be determined by local conditions.

Steam, water and other wastes must be prevented. Pump houses should be built with a view to warmth. To minimize heat losses, boilers, steam pipes and the steam ends of pumps should be insulated where the saving will justify the expense.

The United States Fuel Administration has issued some valuable information in regard to economies to be effected through the proper maintenance and operation of steam power plants and the following is an extract from Engineering Bulletin No. 2, prepared by the Fuel Administration in collaboration with the Bureau of Mines. Acknowledgment is also given Bulletin 155, Department of the Interior, Bureau of Mines and Bulletin No. 8 of the Director General of Railroads, for much of the information contained in this report.

Stopping Fuel Waste

Beginning at the grates upon which the fuel bed rests, see that the air spaces are properly proportioned to avoid the loss of combustible material into the ash pit. This will depend on the kind of coal used. Study the fuel with this point in mind. Five per cent is not an unusual loss from this cause.

The amount of grate surface is important, as it determines the rate of combustion. Ratios of grate area to boiler heating surface will vary from 1:35 to 1:60, depending on the characteristics of the coal and whether hand fired or stoker fired. For power purposes in handfired plants do not permit the rate of combustion to fall below 15 lb. of coal per square foot of grate surface per hour, or go above 28 lb. with bituminous coal.

With settings tight to prevent the infiltration of air, heating surface clean, radiation losses reduced by proper covering, piping and steam mains lagged, engine valves tight and properly set, all condensation returned to the feed-water heater a good start will have been made in fuel conservation.

However, merely placing the plant in good physical condition will not suffice. Conditions change from day to day, from hour to hour, even from moment to moment. These changes must be interpreted, and the degree of intelligence with which they are interpreted marks the degree of success which will be realized in fuel saving. A good plant poorly operated will show low efficiency, while a poor plant skillfully operated will sometimes show a relatively high efficiency. Therefore,

Ultimate efficiency = EXH
Where E = Equipment
and H = Human element.

Find out what the boilers are doing. Provide facilities for weighing the coal; for measuring the feed water; for checking up on combustion; for determining draft; for taking temperature readings at important points. To appreciate the significance of the above items it is desirable to become familiar with the literature of power-plant operation. Read Bulletin No. 1 of the United States Fuel Administration on Boiler and Furnace Testing, Technical Paper No. 80, and various other publications of the Bureau of Mines. In small and moderate sized plants, hand fired, a boiler efficiency of 60 to 70 can be expected. In any given plant determine what efficiency should be expected, considering load and equipment, and keep the plant up to the mark set.

The chief losses in boiler-plant operation are:

Cause.	Remedy.
1. Dirty boiler—loss up to 25 per cent,	Clean boiler
2. Leaky setting—loss up to 15 per cent,	Tight setting
3. Poor firing—loss up to 40 per cent,	Good firing

1. A boiler may be dirty on the inside or outside or both. Dirt on the inside is due to scale formation and can be corrected by cleaning the boiler and then giving consideration to the character of the feed water and its proper treatment. See Engineering Bulletin No. 3 of United States Fuel Administration.

Outside cleaning must receive careful attention. A slight accumulation of soot deposited in a few hours' run will result in a growing loss of efficiency. Some one must be delegated to follow up this matter of soot and see that the cleaning is done thoroughly, frequently, and regularly.

2. Air leaks reduce efficiency. The ordinary brickwork setting develops cracks and crevices which allow a considerable amount of air to enter the setting, lowering the temperature of the gases of combustion. The porous character of the brick itself is such that an appreciable leakage takes place through the walls.

The remedy is to paint up the brickwork with a plastic fireproof mixture and paint or cover the setting with a coat of air-tight material.

3. Bad firing includes allowing holes to develop in the fuel bed; carrying an uneven fire; carrying too thin or too thick a fire; stirring fire, thus forming clinkers; and improper manipulation of dampers. It is here that the human equation becomes of most importance. Attention concentrated on what takes place from day to day in front of the boilers will pay greater returns for the time spent than in any other part of the plant.

The Storage and Handling of Bituminous Coal

It is important, in order to prevent spontaneous ignition, that the following rules be complied with as far as practicable:

The storage ground should not be of a marshy nature or be subject to drainage from any source.

Coal should not be stored near external sources of heat, even though the heat transmitted be moderate, and should be located away from and not stored against buildings.

Avoid admission of air to the interior of the pile through interstices around foreign objects such as timbers or irregular brickwork or through porous bottoms, such as coarse cinders.

Do not permit pieces of wood, oily waste, or other easily combustible material to be mixed with coal during storage, as they may form a starting point for fire.

The height of piles should be limited to 12 ft. Arrange piles in as many units as possible, restricting the length and width as far as possible, in order to provide spacing, not only for ventilation purposes but to expedite rehandling if necessary, and limit the amount of coal in one pile subject to loss. There should be a distance of at least 5 ft. between piles, and this space maintained free for complete ventilation and dispersion of occluded gases.

Pile so that lump and fine coal are distributed as evenly as possible; not, as is often done, allowing lumps to roll down from the peak and form air passages at the bottom of the pile.

Where coal is stowed under shelter or inside of a structure, most perfect surface ventilation should be secured to facilitate the escape of gas by the circulation of the atmosphere.

In coal with a tendency toward heating temperature rises are comparatively gradual, and, if detected in time, complete combustion may be prevented by rehandling. If the ignition point is reached, fire may burn for a considerable time in the interior of a pile before becoming apparent. For the detection and prevention of fires, hollow iron pipes staggered every 50 ft. through the piles may be used, driven within 1 ft. or so of the bottom, these pipes being pointed and closed at the bottom to facilitate installation and provided with a stopper for closing the opening at the top, to prevent the admission of air; daily thermometer readings, or readings every few days should be taken in order that any excessive rise in temperature may be detected readily, and when the temperature has reached 125 deg. rehandling should be started. Coal of high sulphur content should be especially watched, owing to danger of "heating."

Wherever it is possible to do so, all wet coal, and especially that wetted by snow and ice, should be disposed of for immediate use without first being stowed; if, however, its stowage is unavoidable, it should form the top of the pile and be spread out as thinly as may be practicable to expedite drying by evaporation.

The only effectual way of extinguishing fire in coal storage is by rehandling. Water is not generally applied successfully in extinguishing a fire in a coal pile, because it is impossible to saturate the pile thoroughly; the best method of handling coal in danger of fire is to load it out and saturate it so that it will be cooled off thoroughly. The best preventive of loss in coal in coal storage is constant inspection for incipient heating and immediate removal of coal from the spot affected.

Oil Storage

Unlike coal, oil, if stored in closed tanks does not deteriorate when standing nor is it subject to spontaneous combustion; but the greatest care should be given to its storage, as oil and its vapors are very searching and extreme precautions are advisable, though with proper ventilation of the tanks the danger from fire is nil.

Weight for weight, oil can be stored in a smaller space than coal. One ton or 2,000 lbs. of bituminous steaming coal occupies approximately 40 cu. ft. according to A. H. Fay, mining engineer, Bureau of Mines, whereas a ton of oil occupies approximately 35 cu. ft. The relative storage value of coal as compared with oil is therefore 10 to 11.5.

A good steaming coal develops approximately 7,500 calories per gram, according to A. C. Fieldner, chemist, Bureau of Mines. An average fuel oil develops approximatelv 10,500 calories. The relative calorific value, per unit weight, of coal as compared with oil is therefore approximately 10 to 14. For marine steam production, therefore, considering storage capacity, the relative value of coal to oil is 10 to 16.1, although the United States Navy gives a ratio even greater.

The relative efficiency of the steam engine compared with the heavy-oil internal-combustion engine is conservatively 10 to 25. Or, for marine service, the ratio of the total power of a heavy-oil internal-combustion engine for marine propulsion to that of a coal steam engine, considering fuel storage, calorific value of fuel, and engine efficiency, is approximately 10 to 40.25.

Steel tanks for the storage of oil may be secured in all sizes and in accordance with any particular specification, but it is more economical and satisfactory to have sizes and specifications conform to the gage and sizes of sheets commonly carried in stock by the manufacturers, as specifying tanks of special size causes waste through cutting sheets rolled to standard sizes and increases the cost of storage.

The following tables show tanks of various sizes with their capacities and weights that may be built from standard sheets without waste:

Standard Riveted Horizontal Cylindrical Tanks with Flat Heads and Shell of ¼-in. Metal

Capacity Gallons	Size		Weight
	Diam.	Length	
4,000	8 ft.	10 ft. 9½ in.	4,500 lb.
5,000	8 ft.	13 ft. 6 in.	5,400 lb.
6,000	8 ft.	16 ft. ¾ in.	6,200 lb.
7,000	8 ft.	19 ft.	7,000 lb.
8,000	8 ft.	21 ft. 4 in.	7,700 lb.
9,000	8 ft.	24 ft.	8,500 lb.
10,000	8 ft.	26 ft. 7¼ in.	9,200 lb.
11,000	8 ft.	29 ft. 4 in.	10,000 lb.
12,000	8 ft.	31 ft. 10½ in.	10,800 lb.
13,000	8 ft.	34 ft. 8 in.	11,500 lb.
14,000	8 ft.	37 ft. 1¾ in.	12,300 lb.
15,000	8 ft.	40 ft.	13,300 lb.
16,000	8 ft.	42 ft. 6 in.	13,900 lb.
7,700	10 ft. 6 in.	11 ft. 11 in.	6,900 lb.
11,500	10 ft. 6 in.	17 ft. 9 in.	9,000 lb.
15,200	10 ft. 6 in.	23 ft. 7 in.	11,300 lb.
19,200	10 ft. 6 in.	29 ft. 5 in.	13,500 lb.
24,600	10 ft. 6 in.	38 ft. 1 in.	16,900 lb.
	Flat Heads, ¼ in. Shell $\frac{3}{16}$ in.		
4,000	8 ft.	10 ft. 9½ in.	3,800 lb.
5,000	8 ft.	13 ft. 6 in.	4,400 lb.
6,000	8 ft.	16 ft. ¾ in.	5,000 lb.
7,000	8 ft.	19 ft.	5,700 lb.
8,000	8 ft.	21 ft. 4 in.	6,200 lb.
9,000	8 ft.	24 ft.	6,800 lb.
10,000	8 ft.	26 ft. 7¼ in.	7,300 lb.
11,000	8 ft.	29 ft. 4 in.	7,900 lb.
12,000	8 ft.	31 ft. 10½ in.	8,500 lb.
13,000	8 ft.	34 ft. 8 in.	9,100 lb.
14,000	8 ft.	37 ft. 1¾ in.	9,700 lb.
15,000	8 ft.	40 ft.	10,400 lb.

Flat Heads ¼ in. Shell 3/16 in.

16,000	8 ft.	42 ft. 6 in.	10,900 lb.
6,200	9 ft.	13 ft. ½ in.	5,000 lb.
9,300	9 ft.	19 ft. 5½ in.	6,500 lb.
12,300	9 ft.	25 ft. 10 in.	8,100 lb.
15,300	9 ft.	32 ft. 2¾ in.	9,700 lb.
18,200	9 ft.	38 ft. ½ in.	11,300 lb.
7,700	10 ft. 6 in.	11 ft. 11 in.	5,800 lb.
11,500	10 ft. 6 in.	17 ft. 9 in.	7,400 lb.
15,200	10 ft. 6 in.	23 ft. 7 in.	9,100 lb.
19,200	10 ft. 6 in.	29 ft. 5 in.	10,800 lb.
24,600	10 ft. 6 in.	38 ft. 1 in.	13,400 lb.

Standard Welded Horizontal Cylindrical Tanks of 3/16 in. Metal Throughout

550	4 ft.	6 ft.	800 lb.
1,000	5 ft. 5 in.	6 ft.	1,200 lb.
1,500	5 ft. 5 in.	9 ft.	1,600 lb.
2,000	5 ft. 5 in.	12 ft.	2,100 lb.
2,500	5 ft. 5 in.	15 ft.	2,600 lb.
3,000	5 ft. 5 in.	18 ft.	3,000 lb.

Standard Riveted Vertical Cylindrical Tanks with the Bottom and First Ring of 3/16 in. Metal and the Remainder Including the Roof of No. 10 Gage

6,000	10 ft. 6 in.	9 ft. 5 in.	4,100 lb.
9,000	10 ft. 6 in.	14 ft.	5,200 lb.
12,000	10 ft. 6 in.	18 ft. 4¾ in.	6,300 lb.
15,000	10 ft. 6 in.	22 ft. 10 in.	7,000 lb.

Partly or wholly burying oil tanks in the ground is a common practice. However, the ultimate economy is questionable, as the depreciation of the shell from soil corrosion may be rapid, and leaks, unless relatively large, are hard to detect and expensive to repair.

Concrete Tanks

In connection with the use of underground concrete tanks for the storage of oil it is interesting to note that the El Paso & Southwestern has been storing fuel oil of 24 deg. to 38 deg. B., in circular concrete tanks about 12 ft. in diameter by 6 ft. deep at various places along its system for the past five years. The bottoms of these tanks are 8 in. thick and the sides 6 in. thick, and each tank is covered by a concrete roof. The proportion of the mix is 1-2-4 and the largest rock 1 in. The aggregate is thoroughly mixed, and care is taken that when it is placed in the forms it is well tamped and all air bubbles thoroughly worked out so as to insure as dense a concrete as possible.

Tanks that have been in use five years have been examined inside and out but no signs of leakage were discovered. At present the company has 12 such tanks, and their adaptability to oil storage has proved so satisfactory that more are in process of construction. No oil or water proofing compounds are used.

A local electric company at St. Helena, Calif., built a rectangular reinforced concrete tank in 1911. This tank is 16 ft. long, 14 ft. wide and 5½ ft. deep, having a capacity of approximately 10,000 gallons. The bottom is 20 in. thick and the sides 8 in. at the bottom, tapering to 5 in. at the top. Both the sides and the bottom are reinforced with steel rods. At the time the tank was constructed it was coated inside with a solution of sodium silicate. However, after 18 months' service the coating had become practically useless. The tank at this time was examined inside and outside by digging pits, but as no leakage was found no further attempt at oil proofing was made. Since that time the tank has been continually in service for the storage of oil varying in gravity from 15 deg. to 26 deg. B. The roof of this tank is made of wood covered with roofing paper. As a means of lessening evaporation losses and providing a run-off for rain water, as the wooden roof is practically flat, a second corrugated iron roof of proper pitch, has been constructed about 3 ft. above the first roof, allowing free circulation of air between the two.

Oil losses by seepage from properly constructed steel and concrete tanks can be considered practically negligible. The volume of useful hydrocarbon products lost through evaporation in oil storage is a considerable item, however, the loss, of course, being greater in the lighter oils than in the heavy oils, although there is a continued stream of the light hydrocarbons escaping from its surface as long as it remains in storage, even with oil of low gravity.

There are two general rules to follow to prevent evaporation losses: (1) to keep the temperature of the oil in the tank as low as possible, and (2) to make the containers as tight as practicable.

The color of the paint used on storage tanks is an important factor in preventing evaporation. It is reported that tests have demonstrated that evaporation from tanks painted white averages about 1 to 1½ per cent less than from tanks painted red, and about 2½ per cent less than from tanks painted black. These figures have not been verified, but tests made by the Institute of Industrial Research show that dark colored paints absorb heat to a considerable degree.

F. M. Case,
C. R. Knowles,
E. A. Demars,
Committee.

DISCUSSION

(Storage of Fuel at Pumping Stations)

J. B. White:—We have different ways of taking care of our coal but we have found the best so far is the open bin. We use probably from 160 to 200 tons of coal a month, and it doesn't stand very long before it is used.

The President:—What do you think of concrete tanks for the storage of oil?

J. B. White:—I have not given that any consideration. We don't use very much oil on our division, but I should think it would be a good idea. I would rather have them, I believe, than steel tanks.

C. R. Knowles:—Much has been said of late about the conservation of fuel and railroad properties are liberally placarded with instructions on the prevention of waste of coal in firing and through steam and air leaks, but unfortunately little, if anything, has been said about the waste of water and its effect upon fuel conservation. Every pound of coal used in our pumping stations goes to pump water and a fuel waste at the faucet is just as important as one between the coal bin and the stack.

The amount of coal required to pump a thousand gallons of water for general railroad purposes is, of course, a variable quantity as the water is delivered under varying heads and is handled by pumps with a wide variation in efficiency. It is also handled twice in many instances as in boiler washing and water softening plants. However, a conservative estimate of the average coal consumption per thousand gallons of water pumped is 25 lbs. On this basis the coal required to pump the water used by railroads is approximately 22,500,000,000 lbs. or 11,500,000 tons. The saving in fuel through the prevention of water waste would be 2,300,000 tons. To haul this coal unnecessarily consumed in pumping water to be wasted requires 57,500 cars of 40 tons capacity, or 1,150 coal trains of 50 cars each—more than three trains of coal per day every day in the year for no purpose other than to make up for gross carelessness in the use of water. There is an additional waste of fuel consumed in hauling this coal and in using cars that are badly needed for other purposes. Assuming that four days' time of each car is consumed in delivering the coal from the mine to the point of consumption and the value of the cars at $5 per day each, the total loss from this source alone is $1,150,000.

E. A. Demars:—Mr. Knowles' analysis is very thorough. It is the waste of the water more than the waste of the fuel at the pumping stations that creates the greatest cost. I have noted on many occasions where we could be very conservative with fuel, but due to the careless handling of the standpipes and tank spouts as much as a half tank of water has been wasted by the train men, so it would seem that more care should be taken in the handling of standpipes and tank spouts to prevent the waste of water.

L. A. Cowsert:—I want to mention the effect of stacks on the saving of fuel. There are many different opinions about the proper height of stacks for stationary boilers. I always like to use a stack not less than 30 ft. high for pump boilers, on account of different grades of coal we get in picking it up with the dirt and sand around the chutes.

C. R. Knowles:—I would like to ask if you don't find a large waste through having too much coal stored? Are there not times when you are forced to unload and take care of a lot of coal from coal chutes or a lot of screenings or other low grade coal that has to be disposed of?

A. S. Markley:—We store only about a car and a half or two cars of coal at a time, sometimes four. We use clam shells for unloading, which is more economical than unloading by hand.

A. W. Harlow:—The supervisor of locomotive operation on our road is a fanatic on the economical use of fuel. He watches the stacks of the pump house boilers, as well as the locomotives. We fire our boilers a shovel full at a time, instead of filling them up and shooting out a lot of black smoke. I believe that the firing of the boilers is one of the points that we ought to consider in the economical use of fuel. Some people say that it takes black smoke to make steam, but it doesn't, for you can fire a boiler without black smoke. We generally start out with a work train and a locomotive crane, and unload our winter's supply in the fall. We have no particular storage bins for pumping stations. Then in the summer we handle a car load at a time.

Jas. Dupree:—There is another large factor in fuel conservation—the waste of water. It is not only wasted from standpipes, but also at hydrants at cinder pits, the little pipes in the roundhouses, etc. I think the waste of water is a larger factor than the waste of fuel, because the man that pumps the water is not going to shovel any more coal than he has to in order to keep up steam.

E. A. Demars:—I presume the largest waste at pumping stations results from storing too much coal, especially if the quality of the coal is very soft. Very soft coal deteriorates rapidly. I have known several occasions where it was necessary for the pumpers to screen this soft fine coal and they threw out all the coal that went through the screen, along with the ashes, and as much as a half carload of coal has been thrown out with the ashes at a time, owing to its soft quality and deterioration.

Another condition that exists at pump stations which should be watched carefully is the condition of the grates. If the pumper permits his grates to burn out and get cracked and loose, sometimes as much as 25 or 50 per cent of the coal that he puts into the fire box goes into the pit unburned. I have seen where tie plates and pieces of iron pipes were put in boilers in holes where the grates had been burned out, to keep the coal from dropping through.

G. W. Rear:—There is another waste that no one has spoken of; that is the waste from the theft of coal around the pumping stations. I know, to my positive knowledge, of four pumping stations in Eastern States that supply their whole neighborhoods with coal. I believe that the conservation of fuel can be promoted to a considerable extent by keeping the coal locked up; also by a little judicious sleuthing now and then to see whether the coal is actually being burned under the boilers.

J. S. Robinson:—At the water stations we have small platforms or bins into which we put a car of coal at a time. The time of the local freight, or of a special train to unload the coal at different stations ($105 a day for a work train), amounts to a good deal in the cost of the coal, and I think we ought to consider that. It would be a great deal better to line your coal bin with old boiler plates or anything you can get, or even build a concrete bin that will hold five or six car loads at a time so you would have a winter's supply.

Jas. Dupree:—Since a cost of $105 a day for a train adds much to the cost of the coal, wouldn't it be cheaper to put in a spur track at the place? A switch costs about $100. To be sure, you may have the switch on a high speed track, which is dangerous, but I think it would be cheaper to put in a spur track and set the coal near the pumping station and let the men unload it at their leisure.

E. T. Howson:—I ran across a manner of unloading coal two or three years ago which is applicable to certain stations. That is the use of the ordinary dump car, loading coal at those points where it can be loaded conveniently, the way-freight taking it out, dumping it quickly and going on. Where the storage is below the tracks the coal can be dumped onto an inclined platform.

Another thought occurred to me in the consideration of the economical use of fuel, which has been touched on in previous reports before this association. That is, when the time comes for a selection of pumping plants, the consideration of the economical fuel. Once the plant is installed you can't change from oil to coal or the reverse, but before it is installed, when the consideration of the fuel question is brought up, that opportunity is presented. The fuel situation has changed so rapidly in the last few years that previous estimates of economies must be revised on the basis of present information. The use of fuel oil has been discontinued in certain parts of the country, but in many other parts of the country it is expanding. My attention was called yesterday to two large railroads that have just contracted for a two years' supply of fuel oil for divisions comprising several hundred miles, on which coal had been used, but on which fuel oil is now to be used, just an instance of changing conditions which have made fuel oil more economical than the coal. In other places the reverse is true. There are times when we can switch from one fuel to the other with considerable economy.

A. S. Markley:—A great mistake is made in many instances in having too small machinery. I have in mind a place where we have a small pump that pumps from six to seven hours a day to get the supply of water. We installed larger equipment and the pumper now fills his tank in two hours with 50 per cent less consumption of fuel.

Speaking about the theft of coal at night, we tallied up the consumption of coal for a year, when the coal was lying outside, and then we put it into a coal house under lock and key, and we saved 30 per cent of the coal that year.

W. J. O'Brien:—I wonder what success others may be having in furnishing warm water to the boiler feed in rural districts. We tried it on our road with good results.

C. R. Knowles:—I guess some of the older members know my attitude toward the use of locomotive boilers in pumping stations. If anyone gives me an old second hand locomotive boiler in pumping stations for use in pumping water, he is not interested in fuel conservation. If we are going to save fuel, and if we are going to effect further economies, scrap the old locomotive boiler, because it is nothing but a fuel waster. As far as the use of boiler feed water heaters is concerned, I think they are coming into more general use, especially at the larger pumping stations. Many of the Eastern railroads have used boiler feed water units for a number of years, and I notice them coming into pretty general use on the Western roads also. The Eastern roads use them primarily at the larger stations where they have track pans. Of course they require quite a large power plant and considerable heating apparatus, but there are quite a number of them going in on Western roads, particularly since the smaller sizes of feed water heaters have been made more efficient.

Jas. Dupree:—Mr. Knowles' point is well taken. It is a fact that a locomotive boiler is the poorest thing in existence for a stationary boiler. The flues are too small. I would suggest throwing them into the scrap heap—the sooner the better. It will be money saved if you get rid of them. Flues should be of a large size, with plenty of room from the hand plates and over the top of the boiler; big hand plates so they can get everything out and clean out thoroughly, if you are going to conserve fuel, and that is what we are working on at the present time.

J. T. Andrews—(B. & O., By Letter):—I note that this report seems to apply very largely to large stations or power plants and not to small type stations, such as the majority of railway water stations are. This applies particularly to the discussion in reference to stopping fuel waste.

While the points noted are undoubtedly correct, I believe that the conditions existing at most of our pumping stations call for education of the human element, rather than the installation of highly efficient equipment. I doubt if it is very practicable to make any large expenditures for boiler lagging and pipe covering at such stations, as the initial cost and maintenance would probably overshadow the benefits to be derived. Good firing is the most important point. I believe that a proper course of instruction of the pumpers would accomplish better results than anything else.

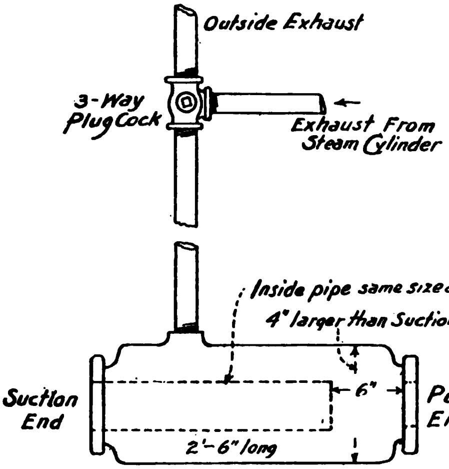
As to some stations where we have larger boilers, it would probably pay to install small feed water heaters, it being a well known fact that a very material saving can be made in fuel with any material increase in the temperature of the boiler feed water. The cost of such a device would not be very heavy. Another inexpensive attachment which is lacking at most of our small water and power stations, is a damper on the smoke stack, and it would pay to install them, provided the pumpers were properly instructed as to their use.

With regard to the storage of coal; the report applies almost entirely to large power plants. At the usual water station, I believe that we can best fulfill the requirements by having a clean and tight bin, free from obstructions and capable of holding not less than one month's and not more than two months' supply. Delivery should be made from a trestle wherever it is possible to do so, in order to save labor of handling.

Regarding oil storage; the tanks should be of sufficient size to hold a tank carload in order to take advantage of the lower prices at which oil is usually obtained in such lots. I note that the report is not in favor of burying the tanks, but I believe that this should be done, as it will result in keeping the fuel at a lower and more even temperature. I also note some remarks as to the effect of the color of paint upon evaporation and believe that this is a very interesting point which should be developed further. I believe that concrete tanks will probably be preferable for oil storage, both on account of the cost and the possibility of burying them without the disadvantages mentioned, if this was done with steel tanks.

No mention is made as to the storage of gasoline and kerosene, but I consider that this can be best taken care of by the use of comparatively small tanks, holding from 250 to 500 gal. If tanks of larger capacity are used, the evaporation losses with both classes of fuel will probably be very heavy.

A point which is to be considered, is that in handling any of the classes of liquid fuel a proper pump should be provided which will reduce the manual handling to a minimum in order to avoid waste.


Outside Exhaust
3-Way Plug Cock
Exhaust From Steam Cylinder
Inside pipe same size as Suction pipe
4" larger than Suction pipe
6"
Suction End
Pump End
2'-6" long

Note: Starting pump allow steam to pass outside. Close cylinder cocks then turn exhaust into drum by turning 3-Way cock.
When steam is turned into drum pump will speed up.
It is advisable to use hard rubber hot water valves in water end

Apparatus for Using Exhaust Steam from Pump to Tank to Prevent Water in Tank from Freezing. C.F. Warcup. (G.T.R.)

RAILWAY FIRE PROTECTION EQUIPMENT

By C. R. Knowles

Superintendent Water Service, Illinois Central Railroad

The subject of fire-extinguishing apparatus is necessarily one of great detail and brings out the study of the extent and character of the properties, the natural conditions surrounding them, and their use and occupancy. The class of appliances will necessarily cover a wide range, starting, however, with the idea of having an ample supply of water to meet the maximum conditions that may arise. Careful study is necessary to determine the specific character of the fire-extinguishing devices required to meet the demands of each class of property. These include the use of water mains and fire-hydrant systems under ample volume and pressure from public or private reservoir or other source of supply, with incidental fire pumps, elevated tanks, standpipes, fire hose, fire extinguishers, steam jets, sand pails, water barrels and pails; all of which must be studied and installed with due regard to their relative values. An important fire-fighting agency on railroad properties is the locomotive or yard engine used at terminals and large yards remote from public protection, so equipped for supplying water under pressure with the aid of fire hose as to give good service in the event of fires in rolling equipment and its lading.

The five principal fire extinguishing agents in use on railroads are as follows:

Bicarbonate of Soda,
Caustic Soda and Sulphuric Acid,
Carbon-tetrachloride,
Dry Sand,
Water.

The class of appliance or equipment for handling the above agents properly will necessarily cover a wide range, and it is not the intent of this paper to discuss the various appliances in detail as a careful study of the extent and character of the property is necessary to determine the type of fire extinguishing equipment best suited to meet local conditions and the demands of each class of property.

Where definite recommendations are made they are in accord with the requirements of the National Board of Fire Underwriters and instructions given in Bulletin No. 8, " Manual on Fire Protection for Railroad Properties," issued by the Director General of Railroads in 1919. Acknowledgment is given to this bulletin for much of the material contained in this paper.

The various extinguishing agents given above and the equipment for their proper handling will be discussed briefly in the order given.

Bicarbonate of Soda

This is nothing more than common baking soda and is usually contained in tin tubes; it is useful only in incipient fires and is of but little value as a fire extinguisher. The use of dry powder extinguishers of this type should be discontinued as too much reliance may be placed upon them, thus delaying the use of other more efficient extinguishing agents.

Caustic Soda and Sulphuric Acid

Chemical fire extinguishers using soda and acid are usually furnished in the 2½-gal. hand type and in the 40-gal. type mounted on wheels. The hand type is one of the best fire extinguishers known for small incipient fires. As many of them are located at points where there is no other fire protection it is important that they be kept in perfect order at all times. They should be discharged, cleaned and recharged at least once each year, the date of recharging to be marked on the tag attached to the extinguisher. At least two extra charges should be on hand for each extinguisher.

The care of extinguishers should be assigned to some particular man at each point as a division of responsibility for their condition will lead to neglect. They should be inspected weekly; this inspection should include a careful examination of the nozzle, hose and hose connection and the renewal of defective parts as soon as discovered. Instructions as to the recharging and care of these extinguishers should be carried out rigidly as efficient operation depends upon instructions being followed explicitly.

Extinguishers of this type should not be exposed to freezing temperature, if it is possible to avoid it, and should be accessible at all times. Hand extinguishers should be hung in accessible places with their tops not more than six feet from the floor. Only those approved by the National Board of Fire Underwriters should be used as others are dangerous and their use may result in injury to the operator unless they have been properly tested out.

Carbon-tetrachloride

This liquid is particularly effective on fires in hazardous liquids, other rapidly burning materials, electrical fires and other fires not readily extinguished by water. The extinguisher for using this liquid is usually of the one-quart pump type and, on account of the small size, is of value only in incipient and small fires. The freezing point of carbon-tetrachloride is 25 to 50 deg. below zero, therefore, it is very desirable where low temperatures prevail. These extinguishers should receive the same care as other chemical extinguishers and should be kept full of liquid at all times. A reserve supply of liquid for refilling should also be available.

Sand

Sand is useful chiefly in oil fires and should be contained in pails or properly constructed sand boxes with scoops for throwing. The sand should be clean and dry and the supply should be located near a doorway in order that it may be accessible. The boxes or pails containing the sand should preferably be above the floor to keep the sand free from dirt and moisture.

Water

Water is, of course, the principal agent used in fighting fire, all other agents being of value chiefly on incipient fires, or in chemical, oil and electrical fires which are usually limited in extent. Therefore, from whatever source water is obtained for fire purposes, the supply should be ample and constant. This is the first requisite. Second only to an ample supply of water is the importance of adequate facilities, properly constructed and so located as to permit fighting the fire with a minimum of delay.

Fire Pumps

The fire underwriters have laid down extensive rules and regulations governing the design, location, maintenance and operation of pumps used for fire purposes. These rules are so well known and easily obtained that it is hardly necessary to quote them here.

Unfortunately there are but few pumps used exclusively for fire protection on railroads, the average pump being designed and used primarily for general service pressure. Fire protection being incidental, therefore, it is impractical to apply these regulations to all pumps without impairing the service for which they are primarily designed.

It is sufficient to say that where service pumps are also used for fire protection their operation should conform as closely as possible to the rules laid down for fire pumps. All connections between service and fire lines should be equipped with proper valves, plainly marked and their use fully understood by all concerned.

Pipe Lines

Pipe lines serving fire hydrants and fire connections should be independent of general service where possible, but if a part of the general service system they should be so constructed and arranged that service connections can be cut off and full fire pressure maintained on hydrants and hose connections. Underground lines should be of cast iron, laid in complete circuits or girdironed when practical to do so, and should be not less than six inches in diameter except where extensions are being made to existing lines of smaller diameter. They should be laid to a sufficient depth to prevent freezing and should not be run under buildings.

Valves

Post indicator valves should be used to control all underground fire mains wherever possible. If post indicator stands are not practical for any reason, valves should be located in valve pits and their location and purpose plainly indicated by signs. Where fire mains are connected direct to general service lines a check valve should be placed so that it will close automatically when fire pressure is applied or a post indicator valve installed and its purpose fully understood.

Hydrants

Fire hydrants shou'd be of an accepted type offering the lowest resistance to the flow of water. Ground or outside hydrants should be of the two-way type and should be designed to drain automatically when the valve is closed, to prevent freezing. It is very desirable that the outlets be fitted with independent hose valves. All outlets from ground hydrants should be 2½-in. openings. Threads on hydrant connections should fit the connections on public fire department hose. Hydrants should be located far enough from buildings to prevent them being inaccessible during a fire, or from being put out of service from falling walls; 50 to 75 ft. is usually the proper distance. They should be painted white so they may be located readily at night. They should be inspected frequently to see that they are in proper condition and that they drain properly to prevent freezing. Under no circumstances should fire hydrants be used for other than fire purposes. Hydrant wrenches and spanner wrenches for tightening hose should be located conveniently and in sufficient number to provide at least one for each hydrant.

Water Barrels and Buckets

Number recommended:

In passenger stations, three pails for buildings of ordinary size, increasing the number by one pail for about each 500 sq. ft. of floor space over the first 2,000 sq. ft.

In freight stations at least one barrel and two pails for buildings of ordinary size; increasing the number in larger buildings by one barrel and two pails for each additional 3,000 sq. ft. of floor space over the first 3,000 sq. ft., so as to make them readily accessible to all parts.

In combined passenger and freight stations, one barrel and two fire pails to be placed in the freight room, increasing the number in larger buildings as indicated for freight stations.

In shop buildings, one barrel and two pails to be distributed for about each 3,000 sq. ft. of floor space.

In warehouses, two pails for a floor space of 1,000 sq. ft. or less, increasing the number by one pail for each additional 500 sq. ft.

In other and miscellaneous property as conditions may require and permit.

Barrels to have a capacity of not less than 50 gal.

Freezing

When fire barrels and pails are located where there is a liability of the water being frozen in cold weather, it is recommended that chloride of calcium or salt be placed in each to retard freezing. The density of the solution required will depend upon existing temperatures. The following tables have been suggested as appropriate mixtures for the solution:

Commercial calcium chloride

Lbs. per Gal.	Freezing point Deg. F.
½	29 above zero
1	27 above zero
1¼	25 above zero
1½	23 above zero
1¾	21 above zero
2	18 above zero
2¼	14 above zero
2½	8 above zero
3	zero
3½	6 below zero
4	17 below zero
4½	27 below zero
5	39 below zero
5½	54 below zero

Common salt (sodium chloride)

Lbs. per Gal.	Freezing point Deg. F.
½	24 above zero
1	18 above zero
1¼	15 above zero
1½	12 above zero
1¾	9 above zero
2	6 above zero
2¼	3 above zero
2½	1 above zero
3	3 below zero
3½	8 below zero

The solution should preferably be mixed in a vat before being placed in barrels, care being exercised to see that the salt is entirely dissolved. If dumped into a barrel and covered with water, or if thrown into a barrel of water, the salt will be only partially dissolved and unsatisfactory results will be obtained. It is necessary that the chloride of calcium or the salt be dissolved by thorough stirring.

Calcium chloride is possibly superior to salt in the following respects: it does not corrode steel tanks and barrel hoops readily; it has no odor and will remain odorless even if left standing for a long time, and its affinity for moisture prevents evaporation of the water. Where calcium chloride solution is used, wooden barrels should first be well coated inside with asphaltum, or with a mixture of crude paraffin and resin to prevent shrinking of staves and consequent leakage.

Fire Hose

Fire hose is one of the most important of fire-extinguishing agencies, and, as with all fire-extinguishing apparatus, to be reliable it should be of the best material and workmanship. It should always be in perfect working order and at all times properly cared for.

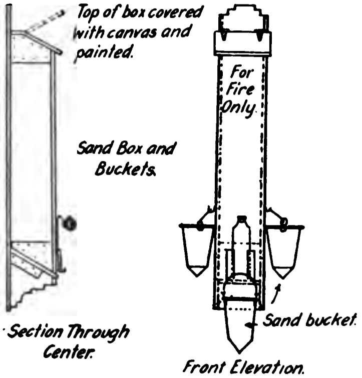
Fire hose is subjected to a severe class of service, the importance of which makes it essential that the utmost care be given to the quality of the materials and the character of the workmanship employed in its manufacture.

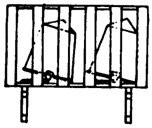
By purchasing only the best hose and giving it the small amount of attention suggested, the greatest practicable durability will be assured.

Experience has shown that a good cotton rubber-lined hose, properly cared for, will frequently last 10 or 15 years.

Cotton Rubber-lined Hose

For use on the yard hydrants of shops, mills, terminals or other property and for the interior of large stations, warehouses, piers, shops, etc., a single "jacketed" or "ply" cotton rubber-lined hose is suitable for ordinary pressures and is recommended. For many yards and buildings it is preferable to the thicker and heavier jacketed hose, as it is easier to handle, more quickly dried and more economical. For yards or buildings where hose will receive rough handling or be liable to heavier wear and pressures, the same quality of hose is recommended with additional jackets, separate or interwoven, composed of the same kind of cotton fabric. The light grades of fire hose on the market, generally known as "mill hose," are too light and generally of too low grade for the best service in shops, and terminals, and are not recommended.

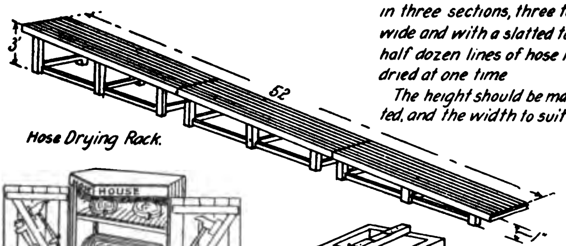




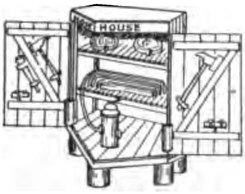
One barrel and two buckets must be located in buildings up to 2500 sq. ft of of floor space, increasing the number by one barrel and two buckets for each additional 1500 sq. ft of floor space, they should be placed so as to be readily accessible by leaving open passageways to them and by keeping the tops of barrels free from obstruction. Buckets must be placed in a crate over the barrels.

A hose rack similar to that shown below is recommended for drying hose after it has been wet either at a fire or at a test. The sketch shows a rack in three sections, three to four feet wide and with a slatted top so that a half dozen lines of hose may be dried at one time

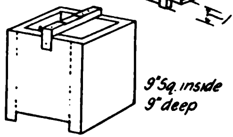
The height should be made as indicated, and the width to suit conditions



Hose Drying Rack.



Standard Hose Hydrant House.



Bucket for Bridges and Trestles Constructed of 1" Boards.

For use on yard hydrants, no hose smaller in inside diameter than 2½ in. should be used. The loss of pressure is three times as great in 2-in. hose as in 2½-in. hose, and, although where a line of only 50 ft. is used the effect of friction is not much, for longer lines it is a serious detriment.

Unlined Linen Hose

For fire hose to hang up in exceptionally dry, warm rooms, corridors or office buildings, hotels, etc., unlined linen hose is suitable and is recommended. Specifications are also prepared for its manufacture, and purchasers should be assured that hose of this class meets the requirements of the "National Standard." Its chief value is for short lines for brief use inside some classes of buildings where it is best on account of its lightness, compactness, and convenience for use by one man alone.

Two and one-half inch hose is the standard size used for attachment to standpipes inside buildings, depending upon the water supply, although 1¼-in. and 1½-in. hose are lighter and more easily handled, and may be used. The durability depends upon the preliminary preparation and spinning of the fabric; and hose manufactured in accordance with the special specifications for this class of hose is therefore necessary, that it may hold water and stand a high pressure.

Linen hose is injured every time it becomes wet, but if kept in a dry place, it may continue a reliable safeguard for 20 years or more. It is not suitable for lines of more than 50 or 100 ft. in length because of the loss of pressure due to friction caused by its interior roughness; and it is not suitable for outside use, because holes chafe through it quickly under the pulsations of a pump or when laid over sharp stones, cinders, material, or around sharp corners.

It will be seen that only under exceptional conditions is linen hose recommended, on account of the inability to test it or the water facilities, where used.

Care of Cotton Rubber-lined Hose

Owners of hose and those responsible for its care are cautioned and urged (1) to run water through it occasionally (at least four times a year) as it keeps the rubber in good condition and lengthens its life; but to drain the hose and allow the cotton fabric to become thoroughly dry before stowing away again. (2) To test it about once a year to about 500-lbs. pressure to make sure it is in good condition. If put on a cart and allowed to remain after use, wet hose is liable to become damaged quickly. For this reason it should be removed from the cart as soon as it is returned to the hose house, and dry hose substituted. In making this change, the requisite number of lengths of dry hose should be gotten ready, the couplings and washers examined, and the threads treated with a little tallow or mineral oil. The wet hose should be unreeled in sections and the dry hose reeled on. The wet hose should be hung up in a tower or laid on racks to dry. If the hose is dirty, it should be brushed off with a broom after drying. If a drying tower is not practicable, a slanting ventilated hose-drying rack is recommended as a simple and effective arrangement to be used for drying hose after it has been wet, either at a fire or at a test. The rack should be 52 ft. long, 4 ft. or more wide, 1 ft. high at the lower end and at least 3 ft. high at the upper end, and with slatted top, and may be built in sections to facilitate moving. The rack facilitates the proper care of the hose, which will tend to prolong its life and thus reduce the cost of a perishable part of the equipment.

(3) Keep the hose valves tight so that hose will not be wet by leakage. Where cotton rubber-lined hose is attached to standpipes on the interior of large stations, warehouses, piers, shops, etc., in order to prevent leakage entering the hose at hose connections, place a ¼-in. drip cock in the body of valve or a fitting with a drip cock as near the valve as possible, leaving it open to drain away leakage.

(4) To avoid keeping hose in warm rooms, but preferably in a small, well ventilated hose house.

(5) To roll up or stretch out all stock hose, as far as possible, to prevent sharp bends or kinks in it which may injure both fabric and lining.

Care of Unlined Linen Hose

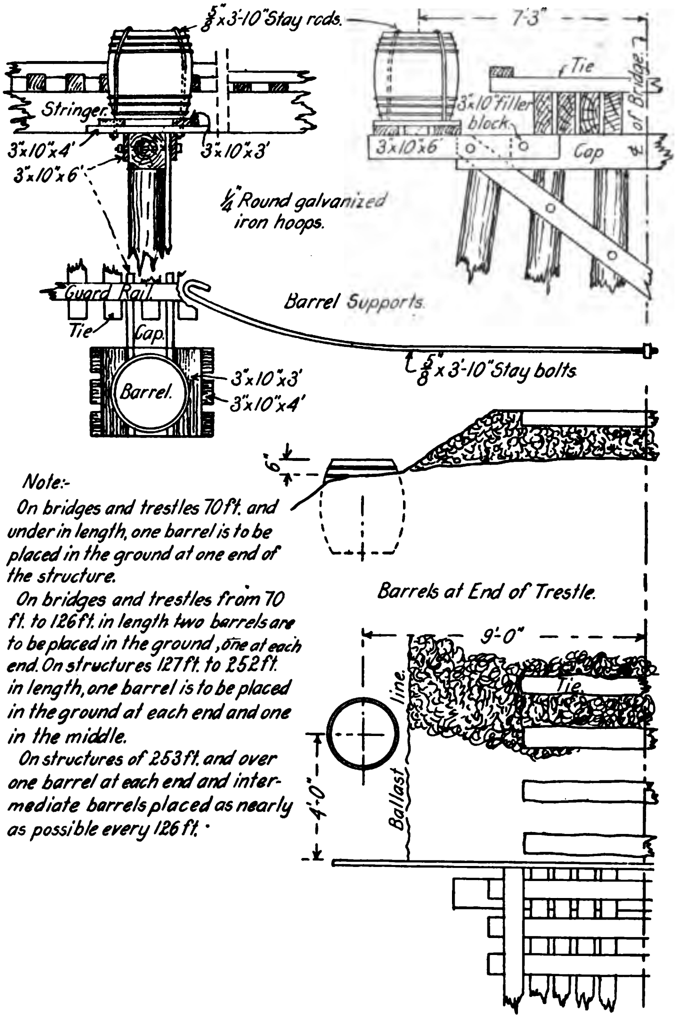
Never wet unlined linen hose except to use at a fire.

Keep the hose valves tight so that it will not be wet by leakage.

This is the most common cause of injury to hose of this kind. Use a well-made brass-bodied gate valve.

To prevent leakage entering the hose at hose connections, place a ¼-in. drip cock in body of valve or a fitting with drip cock as near valve as possible, leaving it open to drain away leakage.

Stretch the hose out from time to time, that it may be dried between the layers. Racks for linen hose should allow it to hang vertically, as this gives better ventilation than if folds are laid horizontally.



Barrel Supports.

Barrels at End of Trestle.

Note:-
On bridges and trestles 70 ft. and under in length, one barrel is to be placed in the ground at one end of the structure.
On bridges and trestles from 70 ft. to 126 ft. in length two barrels are to be placed in the ground, one at each end. On structures 127 ft. to 252 ft. in length, one barrel is to be placed in the ground at each end and one in the middle.
On structures of 253 ft. and over one barrel at each end and intermediate barrels placed as nearly as possible every 126 ft.

The necessity for uniformity in the size and screw threads of hose couplings throughout the country has often been strongly emphasized, as is the case when one neighborhood is likely to call upon another, in the event of a serious fire. A "National Standard" for size and thread of hose couplings and hydrant fittings has been considered and has been adopted by many associations of national influence in matters regarding fire protection and extinguishment. Particular attention is called in this direction to owners or operators of shops and other large properties to see that their fire hose and fire hydrant couplings conform to the National Standard threads wherever possible (2½ in. by 3$\frac{1}{16}$ in., 7½ threads to the inch), but that they are uniform with those of the nearest municipality, so that when the city fire department is called upon, the hose connections may be of service. Where couplings are not uniform, adapters should be provided.

Rigid and systematic inspection of all fire apparatus should be made by specially-delegated employees, preferably members of fire brigades, at least once a week; everything down to the smallest piece of apparatus should be in its place and in good order ready for use, and a report of such inspection should be made to those in authority.

Hose Reel and Hose Rack Specifications

No. 7, Wirt's swinging wall reel for 100 ft. of 2½ in. cotton rubber-lined hose.

No. 4, Wirt's swinging wall reel for 50 ft. of 2½ in. cotton rubber-lined hose.

No. 5, Wirt's swinging wall reel for 100 ft. of 1½ in. cotton rubber-lined hose.

No. 2, Wirt's swinging wall reel for 50 ft. of 1½ in. cotton rubber-lined hose.

(Cotton rubber-lined hose to be used where exposed to moisture and rough usage.)

No. 18X, Wirt & Knox Royal hose rack for 25 ft. to 75 ft. of 1½ in. unlined linen hose.

No. 18Y, Wirt & Knox Royal hose rack for 25 ft. to 75 ft. of 2 in. unlined linen hose.

No. 19X, Wirt & Knox Royal hose rack for 100 ft. to 150 ft. of 1½ in. unlined linen hose.

No. 19Y, Wirt & Knox Royal hose rack for 100 ft. to 150 ft. of 2 in. unlined linen hose.

(Underwriter's unlined linen hose to be used in office and other buildings where not subject to test nor exposed to injury or dampness and on switch engines.)

Hose Cart and Nozzle Specifications

Shop Plant Hose Carts

Wirt & Knox hose cart No. 55, figure 750 with 50 ft. of drag rope, rope reel, two pipe holders, tool box, wrenches, etc., wheels 52 in. dia., wrought frame, steel axle, hose roller in rear. Net weight, 220 lbs. Capacity 500 ft. of 2½ in. C. R. L. hose.

Warehouse Hose Cart

Wirt & Knox Fire Jumper No. 4½, Style I-X pipe holder, tool box, wrenches, etc., axe in spring holder, wheels 48 in. dia., hose roller in rear. Weight 250 lbs. Capacity 400 ft. of 2½ in. C. R. L. hose.

Fire Hose Nozzles

Underwriter's Play Pipe 2½ in. by 30 in. long. Orifice 1⅛ in., screw nozzle wound and painted with metal swivel handle, smooth bore.

Note: This type nozzle to be used on 2½ in. C. R. L. hose outside of buildings. Two underwriter's play pipes to be on each hose cart. C. I. play pipe with brass hose threads, aluminum bronzed 2½ in. by 12 in. long to be used on 2½ in. C. R. L. hose in buildings. C. I. nozzle with brass hose threads, aluminum bronzed 1½ in. by 12 in. long to be used on 1½ in. C. R. L. hose or unlined linen hose.

DISCUSSION

(Railway Fire Protection Equipment)

C. W. Wright:—There is such a small amount of unlined linen hose used on railroads that I don't like to see that reference to it go in as a recommendation of this association or even reference to the fact that there is such a thing as unlined linen hose, as far as railroad fire protection is concerned. It is only in our office buildings that we can use it and not have it abused, and even there it is sometimes abused, for I have seen unlined linen hose reeled out on the floor for scrubbing purposes. Further, I think if we will go on record as saying that any employee using fire apparatus, no matter what it may be, extinguisher, barrels, or hose equipment, and not making an immediate report of it, is subject to discharge without further trial, we will get along a great deal better. It may be a serious matter if an extinguisher or a fire hose has been used, and the couplings marred and not reported to the man who takes care of that equipment so it can be put into proper shape again. We would certainly discharge a man for not making an immediate report. The matter of fire pails for use around stations and warehouses is another serious matter. We have developed a conical shaped pail that we make ourselves, in which we have left a little hole less than a quarter of an inch in diameter in the point of the cone so that it cannot be used for any other purpose. We have demonstrated that a man can stand at a barrel and empty the barrel quicker with that pail than he can with any other, for the water is released without any back-draft. You can put a 50 gal. barrel of water in exactly the place that you want it in an incredibly short space of time. We have received the approval of the insurance department of the Pennsylvania Railroad on it, and I don't believe that the National Board of Fire Underwriters is any harder to satisfy than is that insurance department. There has been great activity during the war period to cause the railroads in the eastern districts to equip with automatic sprinklers. We have opposed them on our piers, particularly, not on the ground that we want to have anything less than the greatest amount of protection possible, but from the fact that piers are subject to considerable vibration, and it is hardly possible to keep a sprinkler system in such condition that it can be depended upon at all times on railroad piers. I believe we would be justified in making an adverse recommendation on sprinkler systems on piers, particularly of lighter construction, with wood piles, etc.

C. R. Knowles:—Mr. Wright's reference to the abuse of unlined linen hose in offices, is probably well founded, but it is not the province of this paper, or of this association, as I see it, to recommend any particular class of hose. Most of us are guided entirely by the ruling of the National Board of Underwriters, and in many cases by our own supervisors and fire forces. The aim and intent of this paper was to suggest the care of railway fire protection equipment, because we realized that we have little to do with the making of the standards, and that we should be interested primarily in taking care of it. Mr. Wright says that railroad fire protection equipment is abused. It is not abused, however, by the maintenance forces, because it is their duty to prevent that abuse as much as posible, and any rules or disciplinary measures intending to enforce the proper care of fire protection equipment would have to come from other departments, so that we really would have no voice in the matter.

The Chairman:—While we are not going to make any definite recommendations in these matters, the fact that Mr. Wright brought up this matter and Mr. Knowles' paper on it, are in the record as valuable information.

A. S. Markley:—How do they handle the water to prevent it from freezing in a sprinkler system in cold weather when there is no fire?

C. R. Knowles:—That is used with a dry pipe system. Nearly all of our coal chutes are equipped with sprinkler systems,—what is known as the " Dry Pipe System,"—the Grinnell pipe valve, in which an air pressure is maintained throughout the system above the valve. That pressure is usually about 30 or 40 lb. and remains on top of the valve. The air jet is of much larger area than the water jet; consequently a lower pressure is required on top to overcome the higher pressure below. The result is that as soon as the sprinkler head is opened from fire or any other cause that releases, causing the valve to open, the system fills with water.

A. S. Markley:—Where the pipes are without water there is an accumulation of rust inside that will close the outlets and also the dead ends.

C. R. Knowles:—The National Railroad Fire Protection Association has published some data on the operation of sprinkler systems at, I don't recall the number, but it seems to me it was on some 16,000 fires, in which the percentage of failure of the sprinkler system was almost negligible.

G. W. Rear:—In the cut showing the water barrel on the trestle, in the report, I want the privilege of submitting an alternate cut for the proceedings. We carried the water barrel on the end of the cap as shown there for many years, but we found on a higher trestle that the barrel was of practically no use to anyone except the bridge man, as an ordinary traveler or neighbor who happened to see a bridge on fire wouldn't take the risk to get out on the bridge and try to get the water out of the barrel. We, therefore, made platforms for the water barrels by extending the ties out far enough to set the barrel up on the deck. These platforms afford a good refuge for anyone who happens on the trestle when a train comes along. We have found them very satisfactory, and we are trying to install them on all our trestles now.

A. S. Markley:—We are trying to furnish dry sand to put out fires on treated timber, treated ties, etc., as we have heard that the more water you put on, the worse it makes the fire. Have you made any provision for that?

C. R. Knowles:—The paper treats with various fire fighting agents, carbon-tetrachloride, dry sand, etc. Dry sand would easily be effective in fires of that kind, which would be classed, I believe, among oil fires. With regard to barrels on trestles the plan shown is simply a general scheme for making the barrel fast. I don't see any objection to fastening it on long ties, or in any other manner in which you might wish to fasten it to the trestle. The fastening, clamp, etc., and the platform would be similar in any case, whether you placed the barrel on a level with the ties or below, as in this case, where it is on the caps. This is not a standard. It is merely one method, and I suppose one will find a dozen different methods on various railroads.

E. K. Barrett:—I have just put in a few docks at Jacksonville, building them with creosoting material. Not having any experience in handling fires in this material, I took the question up with the cresoting plant at Jacksonville, to find out whether water was a good thing to use in fighting fire in cresoting material as I had been advised that the application of water created gas and made the fire burn worse. I was advised that as far as their experience was concerned, water was all right for fighting creosote fires, as they had had a good many fires around their plants, on vessels, tow boats.

etc., and they had always been able to control them satisfactorily with water.

G. W. Rear:—A fire in creosoted material can be fought with water as well as any other fire but a fire in creosote oil itself cannot be fought with water. If the oil should happen to get out on the floor through a leak or break in a tank, it would be unfortunate to try to fight it with water.

A. S. Markley:—Returning to the question of a dry pipe sprinkler system,—if there is not quite enough air in a line the water will come anyway, and if you have freezing weather, away goes the pipe. I can't agree with Mr. Knowles on that sort of a pipe. The only way to be sure about it is to have a man there to shut it off, and keep it shut off.

C. R. Knowles:—This isn't a theory of mine. It is a practice of long standing. We have some 30 or 40 such installations on our line, and they are working satisfactorily. While I am on my feet I want to correct an impression that Mr. Rear evidently has. I am not opposed to his method of fastening the barrel to the bridge in the position of the platform on a level with the ties. I really think it is better than as shown in this report where it is attached to the cap.

A Member:—We have a large storehouse in which we have an automatic sprinkler system, and last spring, by chance, we discovered that our pipes were practically filled with sediment. We used water from a high tower tank as it is at an isolated spot where city water is not available. The sediment and sand practically closed up our piping.

J. S. Robinson:—We have that system in a $500,000 storehouse and we have it inspected once a month.

Note: This Association received the title—American Railway Bridge and Building Association—at the 18th annual convention at Washington, D. C., October, 1908. Prior to that time it was called —Association of Railway Superintendents of Bridges and Buildings.

LIST OF ANNUAL CONVENTIONS.

No.	Place.	Date.	Membership.
1	St. Louis, Mo.,	Sept. 25, 1891	60
2	Cincinnati, Ohio,	Oct. 18-19, 1892	112
3	Philadelphia, Pa.,	Oct. 17-19, 1893	128
4	Kansas City, Mo.,	Oct. 16-18, 1894	115
5	New Orleans, La.,	Oct. 15-16, 1895	122
6	Chicago, Ill.,	Oct. 20-22, 1896	140
7	Denver, Colo.,	Oct. 19-21, 1897	127
8	Richmond, Va.,	Oct. 18-19, 1898	148
9	Detroit, Mich.,	Oct. 17-18, 1899	148
10	St. Louis, Mo.,	Oct. 16-18, 1900	143
11	Atlanta, Ga.,	Oct. 15-17, 1901	171
12	Minneapolis, Minn.,	Oct. 21-23, 1902	195
13	Quebec, Canada,	Oct. 20-22, 1903	223
14	Chicago, Ill.,	Oct. 18-20, 1904	293
15	Pittsburg, Pa.,	Oct. 17-19, 1905	313
16	Boston, Mass.,	Oct. 16-18, 1906	340
17	Milwaukee, Wis.,	Oct. 15-17, 1907	341
18	Washington, D. C.,	Oct. 20-22, 1908	368
19	Jacksonville, Fla.,	Oct. 19-21, 1909	393
20	Denver, Colo.,	Oct. 18-20, 1910	428
21	St. Louis, Mo.,	Oct. 17-19, 1911	499
22	Baltimore, Md.,	Oct. 15-17, 1912	524
23	Montreal, Que.,	Oct. 21-23, 1913	570
24	Los Angeles, Cal.,	Oct. 20-22, 1914	586
25	Detroit, Mich.,	Oct. 19-21, 1915	665
26	New Orleans, La.,	Oct. 17-19, 1916	710
27	Chicago, Ill.,	Oct. 16-18, 1917	704
28	Chicago, Ill.,	Oct. 15-17, 1918	716
29	Cleveland, O.,	Oct. 21-23, 1919	776

	1891-2.	1892-3.	1893-4.	1894-5.
President	O. J. Travis	H. M. Hall	J. E. Wallace	Geo. W. Andrews.
1st. V.-Pres.	H. M. Hall	J. E. Wallace	Geo. W. Andrews	W. A. McGonagle.
2nd. V.-Pres.	J. B. Mitchell	G. W. Hinman	W. A. McGonagle.	L. K. Spafford.
3rd. V.-Pres.	James Stannard.	N. W. Thompsor	L. K. Spafford	James Stannard.
4th. V.-Pres.	G. W. Hinman	C. E. Fuller	E. D. Hines	Walter G. Berg.
Secretary	C. W. Gooch	S. F. Patterson	S. F. Patterson	S. F. Patterson.
Treasurer	George M. Reid.	George M. Reid.	George M. Reid	George M. Reid.
Executive Members	W. R. Damon	G. W. Andrews	O. McNab	James Stannard.
	G. W. Markley.	J. M. Staten	A. S. Markley	James H. Travis.
	W. A. McGonagle	J. M. Caldwell	Floyd Ingram	J. H. Cummin.
	G. W. McGehee.	O. McNab	James Stannard	R. M. Peck.
	G. W. Turner	Floyd Ingram	James H. Travis	J. L. White.
	J. E. Wallace	A. S. Markley	J. H. Cummin	A. Shane.

	1895-6.	1896-7.	1897-8.	1898-9.
President	W. A. McGonagle	James Stannard	Walter G. Berg	J. H. Cummin.
1st. V.-Pres.	L. K. Spafford.	Walter G. Berg	J. H. Cummin	A. S. Markley.
2nd. V.-Pres.	James Stannard.	J. H. Cummin	A. S. Markley	C. C. Mallard.
3rd. V.-Pres.	Walter G. Berg.	A. S. Markley	G. W. Hinman	W. A. Rogers.
4th. V.-Pres.	J. H. Cummin.	R. M. Peck	C. C. Mallard	J. M. Staten.
Secretary	S. F. Patterson.	S. F. Patterson	S. F. Patterson	S. F. Patterson.
Treasurer	George M. Reid.	N. W. Thompsor	N. W. Thompson	N. W. Thompson.
Executive Members	R. M. Peck	W. O. Eggleston	G. J. Bishop	Wm. S. Danes.
	J. L. White	W. M. Noon	C. P. Austin	J. H. Markley.
	A. Shane	J. M. Staten	M. Riney	W. O. Eggleston
	A. S. Markley	G. J. Bishop	Wm. S. Danes	R. L. Heflin.
	W. M. Noon	C. P. Austin	J. H. Markley	F. W. Tanner.
	J. M. Staten	M. Riney	W. O. Eggleston	A. Zimmerman.

	1899-1900.	1900-1901.	1901-1902.	1902-1903.
President	Aaron S. Markley	W. A. Rogers	W. S. Danes	B. F. Pickering.
1st. V.-Pres.	W. A. Rogers	W. S. Danes	B. F. Pickering	C. C. Mallard.
2nd. V.-Pres.	J. M. Staten	B. F. Pickering	A. Shane	A. Shane.
3rd. V.-Pres.	Wm. S. Danes	A. Shane	A. Zimmerman	A. Zimmerman
4th. V.-Pres.	B. F. Pickering	A. Zimmerman	C. C. Mallard	A. Montzheimer
Secretary	S. F. Patterson	S. F. Patterson.	S. F. Patterson	S. F. Patterson.
Treasurer	N. W. Thompson	N. W. Thompson	N. W. Thompson.	N. W. Thompson
Executive Members	T. M. Strain	T. M. Strain	A. Montzheimer	W. E. Smith.
	R. L. Heflin	H. D. Cleaveland.	W. E. Smith	A. W. Merrick.
	F. W. Tanner	F. W. Tanner	A. W. Merrick	C. P. Austin.
	A. Zimmerman	A. Montzbeimer.	C. P. Austin	C. A. Lichty.
	H. D. Cleaveland	W. E. Smith	C. A. Lichty	W. O. Eggleston.
	A. Montzheimer.	A. W. Merrick	W. O. Eggleston.	J. H. Markley.

	1903-1904.	1904-1905.	1905-1906.	1906-1907.
President	A. Montzheimer.	C. A. Lichty	J. B. Sheldon	J. H. Markley.
1st. V.-Pres.	A. Shane	J. B. Sheldon	J. H. Markley	R. H. Reid.
2nd. V.-Pres.	C. A. Lichty	J. H. Markley	R. H. Reid	J. P. Canty.
3rd. V.-Pres.	J. B. Sheldon	R. H. Reid	R. C. Sattley	H. Rettinghouse.
4th. V.-Pres.	J. H. Markley	R. C. Sattley	J. P. Canty	F. E. Schall.
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson.
Treasurer	C. P. Austin	C. P. Austin	C. P. Austin	C. P. Austin.
Executive Members	R. H. Reid	W. O. Eggleston	H. Rettinghouse	W. O. Eggleston
	W. O. Eggleston	A. E. Killam	A. E. Killam	A. E. Killam.
	A. E. Killam	H. Rettinghouse.	J. S. Lemond	J. S. Lemond.
	R. C. Sattley	J. S. Lemond	C. W. Richey	C. W. Richey.
	H. Rettinghouse	W. H. Finley	H. H. Eggleston.	H. H. Eggleston
	J. S. Lemond	C. W. Richey	F. E. Schall	B. J. Sweatt.

	1907-1908.	1908-1909.	1909-1910.	1910-1911.
President	R. H. Reid	J. P. Canty	J. S. Lemond	H. Rettinghouse
1st. V.-Pres.	J. P. Canty	H. Rettinghouse	H. Rettinghouse	F. E. Schall
2nd. V.-Pres.	H. Rettinghouse	F. E. Schall	F. E. Schall	A. E. Killam
3rd. V.-Pres.	F. E. Schall	J. S. Lemond	A. E. Killam	J. N. Penwell
4th. V.-Pres.	W. O. Eggleston	A. E. Killam	J. N. Penwell	L. D. Hadwen
Secretary	S. F. Patterson	S. F. Patterson	C. A. Lichty	C. A. Lichty
Treasurer	C. P. Austin	C. P. Austin	J. P. Canty	J. P. Canty
Executive Members	A. E. Killam	J. N. Penwell	W. Beahan	T. J. Fullem
	J. S Lemond	Willard Beahan	F. B. Scheetz	G. Aldrich
	C. W. Richey	F. B. Scheetz	L. D. Hadwen	P. Swenson
	T. S. Leake	W. H. Finley	T. J. Fullem	G. W. Rear
	W. H. Finley	L. D. Hadwen	G. Aldrich	W. O. Eggleston.
	J. N. Penwell	T. J. Fullem	P. Swenson	W. F. Steffens

	1911-1912.	1912-1913.	1913-1914.	1914-1915.
President	F. E. Schall	A. E. Killam	J. N. Penwell	L. D. Hadwen
1st. V.-Pres.	A. E. Killam	J. N. Penwell	L. D. Hadwen	G. Aldrich
2nd. V.-Pres.	J. N. Penwell	L. D. Hadwen	G. Aldrich	G. W. Rear
3rd. V.-Pres.	L. D. Hadwen	T. J. Fullem	G. W. Rear	C. E. Smith
4th. V.-Pres.	T. J. Fullem	G. Aldrich	C. E. Smith	E. B. Ashby
Secretary	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Treasurer	J. P. Canty	J. P. Canty	J. P. Canty	F. E. Weise
Executive Members	G. Aldrich	G. W. Rear	W. F. Steffens	W. F. Steffens
	P. Swenson	W. F. Steffens	E. B. Ashby	S. C. Tanner
	G. W. Rear	E. B. Ashby	S. C. Tanner	Lee Jutton
	W. F. Steffens	C. E. Smith	Lee Jutton	W. F. Strouse
	E. B. Ashby	S. C. Tanner	W. F. Strouse	C. R. Knowles
	W. O. Eggleston	Lee Jutton	C. R. Knowles	A. Ridgway

	1915-1916	1916-1917	1917-1918	1918-1919
President	**G. W. Rear**	**C. E. Smith**	S. C. Tanner	**Lee Jutton**
1st. V.-Pres.	**C. E. Smith**	**E. B. Ashby**	Lee Jutton	**F. E. Weise**
2nd V.-Pres.	**E. B. Ashby**	**S. C. Tanner**	F. E. Weise	**W. F. Strouse**
3rd V.-Pres.	**S. C. Tanner**	**Lee Jutton**	W. F. Strouse	**C. R. Knowles**
4th V.-Pres.	**Lee Jutton**	**F. E. Weise**	C. R. Knowles	**A. Ridgway**
Sec.-Treas.	**C. A. Lichty**	**C. A. Lichty**	C. A. Lichty	**C. A. Lichty**
Executive Members	**F. E. Weise**	**W. F. Strouse**	A. Ridgway	**J. S. Robinson**
	W. F. Strouse	**C. R. Knowles**	J. S. Robinson	**J. P. Wood**
	C. R. Knowles	**A. Ridgway**	J. P. Wood	**A. B. McVay**
	A. Ridgway	**J. S. Robinson**	D. C. Zook	**J. H. Johnston**
	J. S. Robinson	**J. P. Wood**	A. B. McVay	**E. T. Howson**
	J. P. Wood	**D. C. Zook**	J. H. Johnston	**C. W. Wright**

	1919-1920
President	F. E. Weise
1st. V.-Pres.	W. F. Strouse
2nd V.-Pres.	C. R. Knowles
3rd V.-Pres.	A. Ridgway
4th V.-Pres.	J. S. Robinson
Sec.-Treas.	C. A. Lichty
Executive Members	J. P. Wood
	A. B. McVay
	J. H. Johnston
	E. T. Howson
	C. W. Wright
	G. A. Manthey

CONSTITUTION *

ARTICLE I.

NAME.

SECTION 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT.

SECTION 1. The object of this association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway bridges, buildings and other structures, by investigation, reports and discussions, providing a medium for the exchange of ideas to the end that bridge and building practice may be systematized and improved.

SECTION 2. The association shall neither indorse nor recommend any particular devices, trade marks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussions unless the same have received the endorsement of the association in regular session.

ARTICLE III.

MEMBERSHIP.

SECTION 1. The membership of this association shall be divided into two classes—active and life members.

SECTION 2. To be eligible for active membership, a person must be actively employed in railway service in responsible charge of the design, construction or maintenance of railway bridges, buildings or other structures; a professor of engineering in a college or university of recognized standing; an engineering editor, or a government or private timber expert.

SECTION 3. To be eligible for life membership a person must have been a member of the association for at least five years and in general must have retired from active railway service. The association, however, may waive the latter condition by a majority vote of the members at a regular session for good and sufficient reasons. A life member shall have all the privileges of active membership and shall not be required to pay annual dues.

SECTION 4. Any member guilty of conduct unbecoming a railroad officer and a member of this association, or who shall refuse to comply with the rules of this association, may forfeit his membership on a two-thirds vote of the members present at any regular session of the association.

SECTION 5. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

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* **Revised October, 1914. Amended October, 1916.**

ARTICLE IV.

OFFICERS.

SECTION 1. The officers of this association shall be a president, four vice-presidents, a secretary-treasurer and six executive members, all of whom shall constitute the executive committee.

SECTION 2. The past presidents of this association who continue to be members shall be entitled to be present at all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, nor shall their presence be requisite in order to constitute a quorum.

SECTION 3. Vacancies in any office for the unexpired term shall be filled by the executive committee without delay.

ARTICLE V.

EXECUTIVE COMMITTEE.

SECTION 1. The executive committee shall exercise a general supervision over the financial interests of the association, assess the amount of annual and other dues, call, prepare for and conduct general or special meetings and make all necessary purchases and contracts required to conduct the general business of the association, but shall not have the power to render the association liable for any debt beyond the amount then in the treasury not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

SECTION 2. Two-thirds of the members of the executive committee may call special meetings, thirty days' notice being given members by mail.

SECTION 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE.

SECTION 1. Except as otherwise provided the officers shall be elected at the regular annual meeting of the association which convenes on the third Tuesday in October, and the election shall not be postponed except by unanimous consent of the members present at said annual meeting. The election shall be by ballot, a majority of the votes cast being required for election. Any active member of the association not in arrears for dues shall be eligible for office, but the president shall not be eligible for reëlection.

SECTION 2. The president, four vice-presidents and secretary-treasurer shall hold office for one year and the executive members for two years, three being elected each year. All officers will retain their offices until their successors are elected and installed.

SECTION 3. The term of office of the secretary-treasurer may be terminated at any time by a two-thirds vote of the executive committee. His compensation shall be fixed by a majority vote of the executive committee. The secretary-treasurer shall also serve as secretary of the executive committee.

SECTION 4. The secretary-treasurer shall be required to give bond in an amount to be fixed by the majority of the executive committee.

ARTICLE VII.

ANNUAL DUES.

SECTION 1. Every member upon joining the association shall pay to the secretary-treasurer three dollars membership fee and two dollars per year in advance for annual dues. No member one year in arrears for dues shall be entitled to vote at any election, and any member more than one year in arrears shall be stricken from the list of members at the discretion of the executive committee.

ARTICLE VIII.

AMENDMENTS.

SECTION 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least sixty days previous to said regular meeting.

BY-LAWS*

TIME OF MEETING.

1. The regular meeting of this association shall convene annually on the third Tuesday in October at 10 a. m.

PLACE OF MEETING.

2. Places of holding the next annual convention may be proposed at any regular session of the association. All the places proposed shall be submitted to a ballot vote of the members present at the annual business session and the place receiving a majority of all votes cast shall be declared the location of the next annual meeting. If no place receives a majority of the votes cast, the place receiving the lowest number of votes shall be dropped on each subsequent ballot until a place is chosen.

3. It shall lie within the power of the executive committee to change the location of the meeting place if it becomes apparent that it is for the best interests of the association.

QUORUM.

4. At the regular meeting of the association, fifteen or more members shall constitute a quorum.

DUTIES OF OFFICERS.

5. The president shall have general supervision over the affairs of the association. He shall preside at all meetings of the association and of the executive committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall,

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* Revised October, 1914. Amended October, 1915.

with the secretary-treasurer, sign all contracts or other written obligations of the association which have been approved by the executive committee. At the annual meetting the president shall present a report containing a statement of the general condition of the association.

6. The vice-presidents in order of seniority shall preside at meetings in the absence of the president and discharge his duties in case of a vacancy in his office.

7. It shall be the duty of the secretary-treasurer to keep a correct record of proceedings of all meetings of this association; to keep correct all accounts between this association and its members; to collect all moneys due the association, and deposit the same in the name of the association. He shall invest all funds not needed for current disbursements as shall be ordered by the executive committee. He shall pay all bills, when properly certified and approved by the president, and make such reports as may be called for by the executive committee. He shall also perform such other duties as the association may require.

NOMINATING COMMITTEE.

8. After each annual meeting the president shall appoint a committee of five members, not officers of the association, of whom two at least shall be past presidents, and two of whom shall have served on the committee the previous year, which shall prepare a list of names of nominees for officers to be voted on at the next annual convention, in accordance with Article VI of the constitution, said list to be read at the first session of the second day of said convention. Nothing in this section shall be construed to prevent any member making further nominations.

AUDITING COMMITTEE.

9. At the first session of each annual meeting the president shall appoint a committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary-treasurer and certify as to the correctness of his accounts. Acceptance of this committee's report will be regarded as the discharge of the committee.

COMMITTEE ON SUBJECTS FOR DISCUSSION.

10. After the annual meeting the president shall appoint a committee whose duty it shall be to prepare a list of subjects for investigation to be submitted for approval at the next convention.

COMMITTEES ON INVESTIGATION.

11. After the association has adopted the list of subjects for investigation the president for the succeeding year shall appoint the committees who shall prepare the subjects for report and discussion. He may also appoint individual members to prepare reports on special subjects, or to report on any special or particular subject.

PUBLICATION COMMITTEE.

12. After each annual meeting the executive committee shall appoint a publication committee consisting of three active members whose duty it shall be to coöperate with the secretary in the issuing of the publications of the association. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year.

ORDER OF BUSINESS.

13. 1st—Registration of members.
2nd—Reading minutes of the last meeting.
3rd—Admission of new members.
4th—President's address.
5th—Report of secretary-treasurer.
6th—Payment of annual dues.
7th—Appointment of special committees.
8th—Reports of standing committees.
9th—Unfinished business.
10th—New business.
11th—Election of officers and selection of place for holding next annual meeting.
12th—Installation of officers.
13th—Adjournment.

(Report of nominating committee to be read at first session of second day—Section 9 of By-Laws.)

DECISIONS.

14. The votes of a majority of the members present shall decide any question, motion or resolution which shall be brought before the association, unless otherwise provided.

DISCUSSIONS.

15. All discussions shall be governed by Robert's rules of order.

DIRECTORY OF MEMBERS

Aagaard, P., Supt. Bldgs., I. C. R. R., Chicago
Ailes, N. C., Asst. Val. Engr., D. & H. Co., Albany, N. Y.
Airmet, E. S., For. Ptr., O. S. L. R. R., Salt Lake City.
Alexander, S. Y., G. F. B. & B., St. L. B. & M. Ry., Kingsville, Tex.
Alexander, L. B., Asst. Br., Engr., M. C., Detroit, Mich.
Allard, E. E., For. B. & B., Mo. Pac. Ry., St. Louis.
Allen, T. H., Supv. B. & B., C. & O. Ry., Hinton, W. Va.
Althof, L. W., Supt. Hull Const., Chester Ship Yard, Philadelphia, Pa.
Anderson, August, Gen'l For. B. & B., L. S. & I. Ry., Marquette, Mich.
Anderson, L. J., Supv. B. & B., C. & N. W. Ry., Escanaba, Mich.
Andrews, G. W., Asst., M. of W. Dept., B. & O. R. R., Baltimore, Md.
Andrews, T. O., L. E. & W. R. R., Tipton, Ind.
Archbold, H. L., Div. Engr., Sou. Pac. Co., Tucson, Ariz.
Arey, R. J., 541 So. Cummings St., Los Angeles, Calif.
Ashby, E. B., Consulting Engr., L. V. R. R., New York City.
Ashmore, A. B., Supv. B. & B., M. L. & T. Co., Lafayette, La.
Ashton, D. H., Asst. Engr., O. S. L. R. R., Pocatello, Idaho.
Auge, E. J., Chief Carp., C. M. & St. P. Ry., Wells, Minn.
Austin, C. P., 107 Park St., Medford, Mass.

Bach, C. F., Supv. B. & B., C. & N. W. Ry., Belle Plaine, Iowa.
Bailey, F. W., Supt. M. of W., S. A. & A. P. Ry., Yoakum, Tex.
Bailey, S. D., 633 Hubbard Ave., Detroit, Mich.
Bainbridge, C. N., Engr., Design, C. M. & St. P. Ry., Chicago.
Ball, E. E., Div. Engr., A. T. & S. F. Ry., Fresno, Calif.
Ballard, C. F., Carp. For., S. A. L. Ry., Peachland, N. C.
Baluss, F. C., Engr. B. & B., D. M. & N. Ry., Duluth, Minn.
Barber, N. N., C. E., 6042 Vernon Ave., Chicago.
Barger, T. R., For. B. & B., L. & N. W. R. R., Homer, La.
Barnes, O. F., Div. Engr., Erie R. R., Jersey City, N. J.
Barrett, E. K., Supv. B. & B., F. E. C. Ry., St. Augustine, Fla.
Barrett, J. E., Supt. of Track, B. & B., L. & H. R. Ry., Warwick, N. Y.
Barry, E. J.
Barton, M. M., 311 No. 34th St., Philadelphia, Pa.
Bates, Onward, Civil Engineer, McCormick Bldg., Chicago.
Batey, W. A., Supv. B. & B., U. P. R. R., Kansas City, Mo.
Beard, A. H., 705 No. 11th St., Reading, Pa.
Beck, L., Supt. B. & B., Virginian, Victoria, Va.
Beeler, C. L., Asst. Engr., N. Y. N. H. & H. R. R., New Haven, Conn.
Beeson, R. W., Mast. Carp., C. & S. Ry., Trinidad, Colo.
Bender, Henry, Supv. B. & B., C. & N. W. Ry., Eagle Grove, Iowa.
Bennett, D. E., For. B. & B., Mo. Pac. R. R., DeSoto, Mo.
Bennett, W. J., Asst., Engr., G. N., Seattle, Wash.
Benz, F. A., Div. Engr., B. R. & P. Ry., E. Salamanca, N. Y.
Berry, J. S., Supt. B. & B., S. L. S. W. Ry., Tyler, Tex.
Bibb, J. M., Supv. B. & B., L. & N. R. R., Birmingham, Ala.
Bigelow, F. M., Supv. B. & B., L. A. & S. L. R. R., Salt Lake City.
Bishop, McClellan, Mast. Carp., C. R. I. & P. Ry., El Reno, Okla.
Bishop, R. R., For. B. & B., L. A. & S. L. R. R., Salt Lake City.
Black, G. W., Box 472, Freeport, Ill.

Black, J. D., Supv. B. & B., P. M. R. R., Saginaw, Mich.
Blake, L. M., Supv. B. & B., B. & M. R. R., St. Johnsbury, Vt.
Blowers, S. H., For. Carp., B. & O. R. R., Columbus, O.
Bock, J. G., Gen. Br. Insp., C. St. P. M. & O. Ry., St. Paul, Minn.
Bohland, J. A., Br. Engr., G. N. Ry., St. Paul, Minn.
Bonner, J. K., Asst. Supv. B. & B., N. Y. C. R. R., Rochester, N. Y.
Bourgeois, F. J., Supv. B. & B., N. O. G. N. R. R., Bogalusa, La.
Bouton, W. S., Engr. of Brgs., B. & O. R. R., Baltimore, Md.
Bowers, Stanton, Bradford, O.
Bowers, S. C., Mast. Carp. of Brgs., P. C. C. & St. L. Ry., Steubenville, O.
Bowman, R. M., Certain-teed Prod. Corp., Leader-News Bldg., Cleveland.
Boyd, G. E., Div. Engr., D. L. & W. R. R., Buffalo, N. Y.
Boyer, Grant, Div. For. Bldgs., M. C. R. R., Detroit, Mich.
Bracken, T. F., Gen. For., B. & B., C. St. P. M. & O., Emerson, Neb.
Bratten, T. W., Supv. B. & B., S. P. Co., Oakland Pier, Calif.
Brewer, W. A., Asst. Engr., C. & N. W. Ry., Chicago.
Bricker, H. R., Insp. M. of W., B. & O. R. R., Baltimore, Md.
Briggs, B. A., 1075 LaFayette St., Denver, Colo.
Brink, E. B., Supt. B. & B., L. E. & W., Tipton, Ind.
Brooks, G. E., Mast. Carp., C. R. I. & P. Ry., Rock Island, Ill.
Brown, Alf., B. & B. Insp., P. E. Ry., Los Angeles, Calif.
Brown, C. W., Sou. Pac. Co., Mina, Nevada.
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Stone, L. W., Supv. B. & B., N. Y. C. R. R., Oswego, N. Y.
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Strate, T. H., Val. Engr., C. M. & St. P. Ry., Chicago.
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Strouse, W. F., 400 Forest Road, Baltimore, Md.
Stuart, H. B., Struct. Engr., G. T. Ry., Montreal, Que.
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Sughrue, T. G., Supv. B. & B., B. & M. R. R., Nashua, N. H.
Sullivan, William, Care Div. Supt., Mo. Pac. Ry., Kansas City, Mo.
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Swenson, P., Supt. B. & B., M. St. P. & S. Ste. M. Ry., Minneapolis.

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Zorn, J. F., For. B. & B., Pac. Elec. Ry., Los Angeles, Calif.

Total number of members 775.

Total Number of Members, Jan. 1, 1919,		723
Died,	11	
Resigned and dropped,	17	28
Number of members Oct. 20, 1919,		695
New members Oct., 1919,		80
Total members Oct. 23, 1919,		775

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Cummin, Jos. H.
Findley, A.
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Gooch, C. W.
Green, E. H. R.
Hanks, G. E.
Hubbard, A. B.
Killam, A. E.
Loughery, E.
Lydston, W. A.
Mackenzie, W. B.
McLean, Neil
McIver, B. T.
Mountain, G. A.
Parks, Jas.
Porter, L. H.,
Ross, Wm.
Shane, A.,
Snow, J. P.
Stannard, Jas.
Tanner, Frank
Thorn, J. O.
Wise, E. F.

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Amos, A.
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Bowman, A. L.
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Brantner, Z. T.
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DeMars, James
Dunlap, H.
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Evans, J. J.
Ewart, John
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Forbes, Jno.
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Heflin, R. L.
Henson, H. M.
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Holmes, H. E.
Hubley, John
Humphreys, Thos.
Isadell, L. S.
Johnson, J. E.
Keen, Wm. H.
Lamb, C. W.
Lanning, W. R.
Lantry, J. F.
Large, C. M.
Larson, G.
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Mallard, C. C.
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Marsh, John
McCormack, J. W.
McGehee, G. W.
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McIntyre, Jas.
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McMahon, Geo.
McMahon, J.
Mellor, W. J.
Meloy, E. S.
Millner, S. S.
Mitchell, J. B.
Mitchell, W. B.
Morgan, J. W.
Morgan, T. H.
Morrill, H. P.
Mountfort, A.
Nelson, J. C.
Noon, W. M.
Patterson, S. F.
Peck, R. M.
Perry, W. W.
Phillips, H. W.
Powell, S. J.
Powell, W. T.
Redinger, C. A.
Reid, G. M.
Renton, Wm.
Reynolds, E. E.
Rice, A. P.
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Schwartz, J. C.
Sheldon, J. B.
Soles, G. H.
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Spaulding, E. C.
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Spencer, Wm.
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Trautman, J. J.
Travis, O. J.
Vandegrift, C. W.
Van Der Hoek, J.
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Wallace, J. E.
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Wells, J. M.
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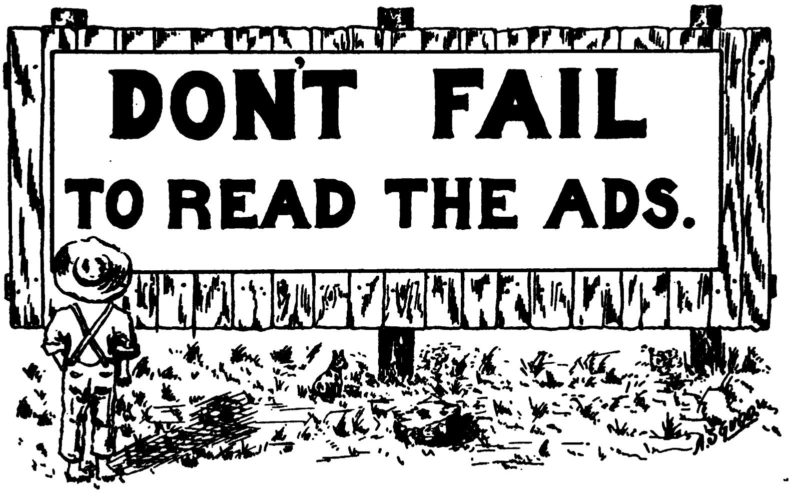

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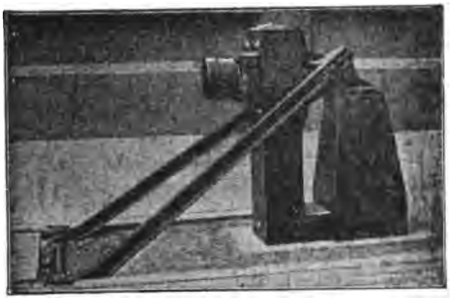

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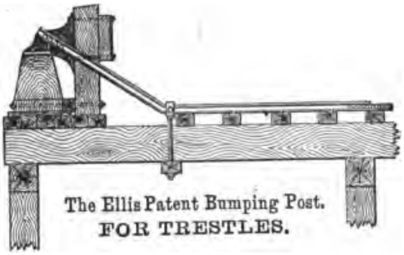

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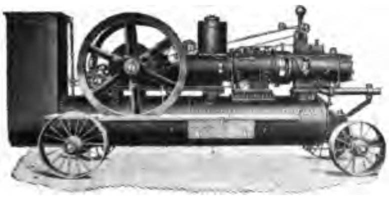

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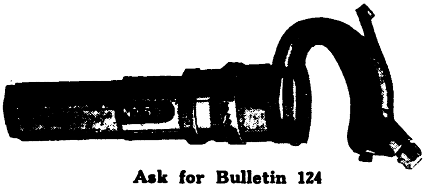

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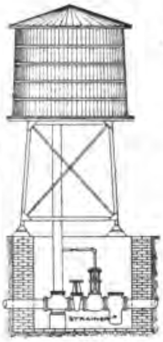

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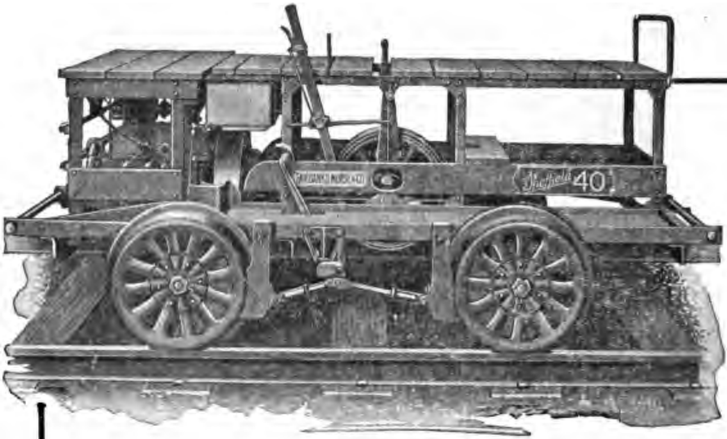

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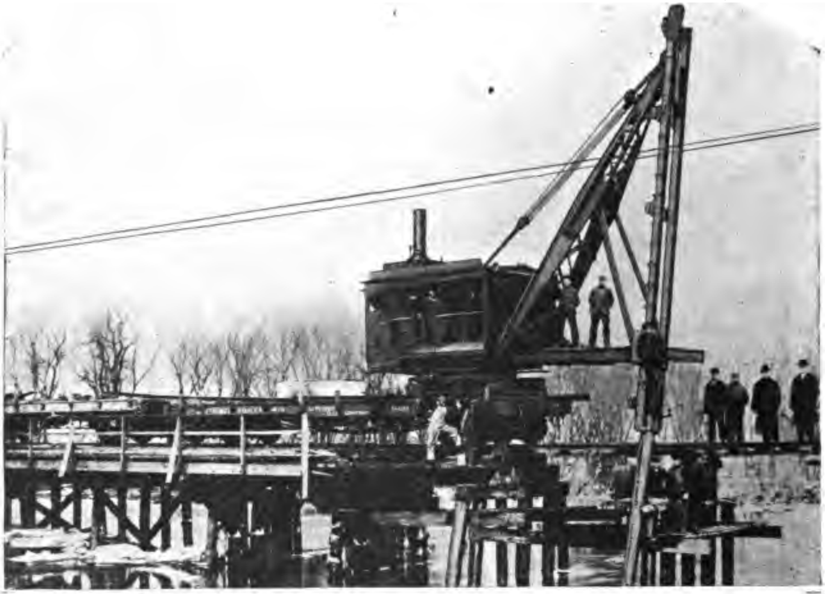

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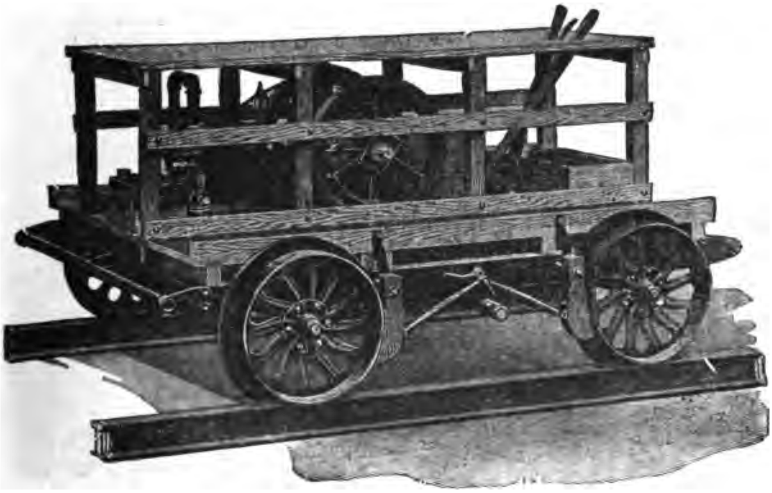

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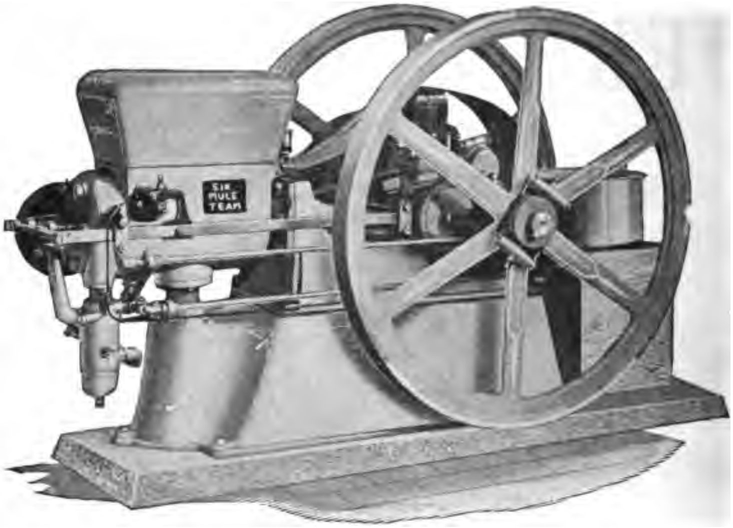

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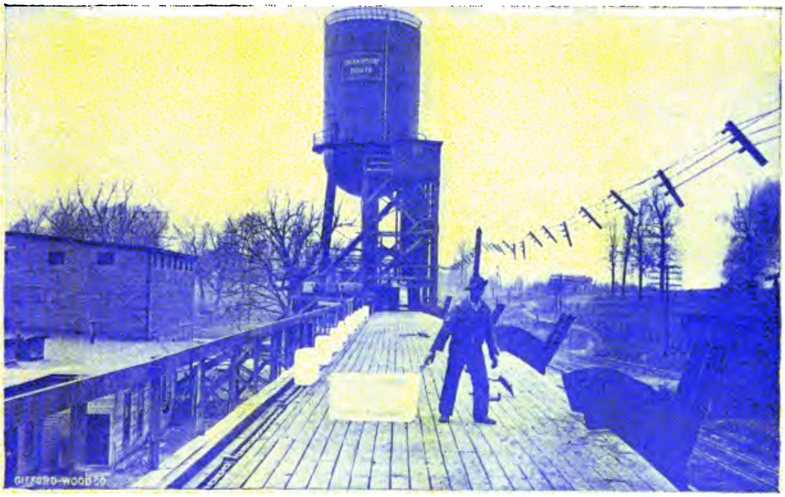

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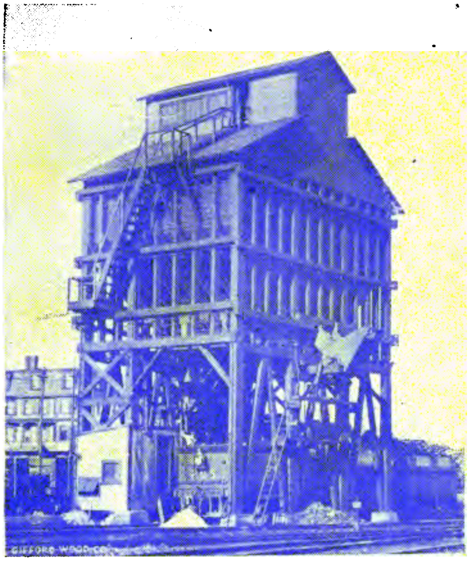

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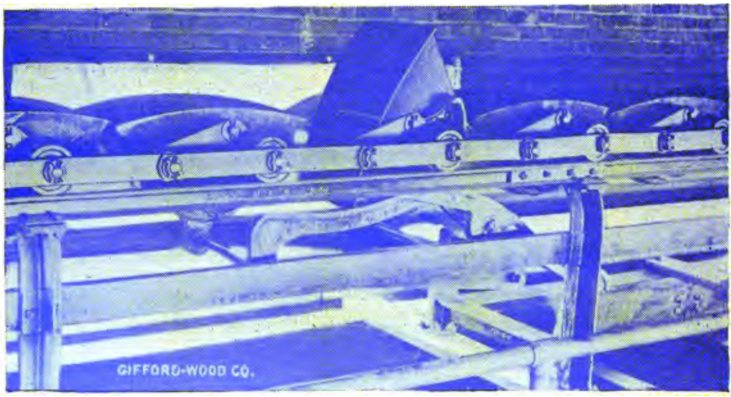

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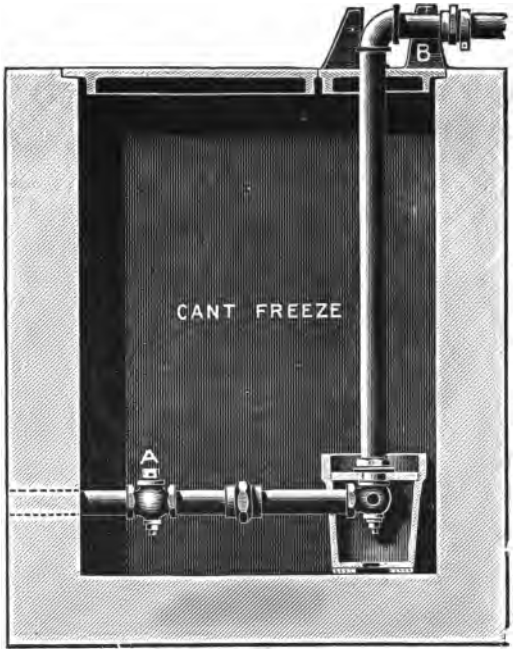

Fig. 4—Concrete or Brick

No digging necessary to renew valves of Fig. 4. This form is standard for all sizes, ¾ to 2½ inch

How to Order Fig. 4 Hydrants

If an installation such as Fig. 4 is desired, make order read "one (mention size) hydrant complete Fig. 4, January 1914 Catalog or March 1917 Bulletin."

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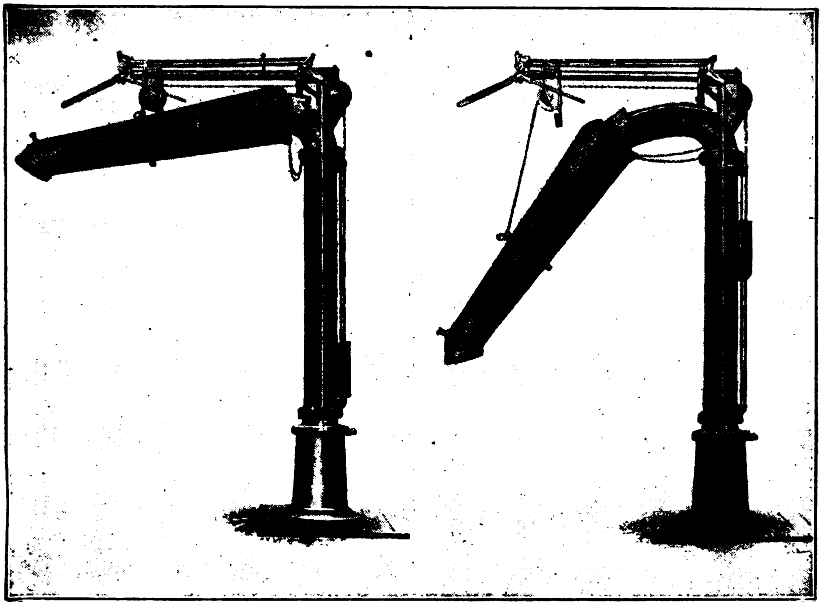

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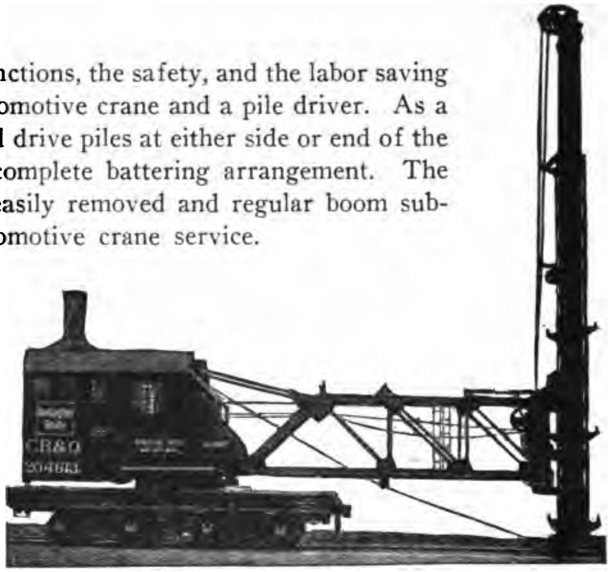

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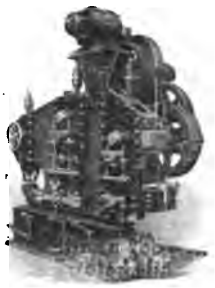

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